

Biennial Remedial Action Status Report for the OU 7-08 Organic Contamination in the Vadose Zone Project

A. Jeffrey Sondrup
Lisa A. Harvego
L. Todd Housley

September 2005

**Idaho
Cleanup
Project**

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L. Todd Housley

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Idaho Cleanup Project
Idaho Falls, Idaho 83415

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ABSTRACT

This report describes the remedial action activities performed between January 2002 and June 2005 for Operable Unit 7-08 at the Idaho National Laboratory. Operable Unit 7-08, Organic Contamination in the Vadose Zone, extends from the land surface to the top of the Snake River Plain Aquifer approximately 177 m (580 ft) beneath the Radioactive Waste Management Complex excluding the Subsurface Disposal Area disposal pits and trenches. The vadose zone contains volatile organic compounds primarily in the form of organic vapors that have migrated from buried waste in the Subsurface Disposal Area pits. The objective of the remedial action is to reduce the risks to human health and the environment associated with the organic contaminants present in the vadose zone and to prevent federal and state safe drinking water standards from being exceeded in the future.

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ACRONYMS

ARP	Accelerated Retrieval Project
CCl ₄	carbon tetrachloride
CHCl ₃	chloroform
DEQ	Idaho Department of Environmental Quality
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FTIR	Fourier transform infrared (spectrometer)
FY	fiscal year
INL	Idaho National Laboratory
OCVZ	organic contamination in the vadose zone
OU	operable unit
PCE	tetrachloroethene
RA	remedial action
RAO	remedial action objective
RG	remediation goal
RI/FS	remedial investigation and feasibility study
ROD	Record of Decision
RWMC	Radioactive Waste Management Complex
SDA	Subsurface Disposal Area
TCA	1,1,1-trichloroethane
TCE	trichloroethene
VOC	volatile organic compound
VVET	vapor vacuum extraction with treatment

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1. INTRODUCTION

1.1 Purpose

The objective of the Operable Unit (OU) 7-08 Remedial Action (RA), as stated in the OU 7-08 *Record of Decision* (ROD) (DOE-ID 1994), is to reduce the risks to human health and the environment associated with the organic contaminants present in the vadose zone within the Radioactive Waste Management Complex (RWMC) and to prevent federal and state safe drinking water standards from being exceeded in the future. As stated in the ROD (DOE-ID 1994), the remedy selected to accomplish this objective is vapor vacuum extraction with treatment (VVET). Vapor vacuum extraction with treatment extracts organic contaminants from the subsurface and subsequently destroys them at the surface by means of recuperative flameless thermal or catalytic oxidation processes. The purpose of this report is to describe RA activities performed between January 2002 and June 2005.

1.2 Background

The OU 7-08 *Remedial Investigation/Feasibility Study* (RI/FS) (Duncan, Troutman, and Sondrup 1993) identifies the physical characteristics of the RWMC site, provides a summary of the contaminants present in various media at the site, and identifies current risk factors. Four alternatives for remediation of the site were examined.

The RI/FS (Duncan, Troutman, and Sondrup 1993) investigated the subsurface strata at the Subsurface Disposal Area (SDA) and characterized the sequence of fractured basalt and sediments. The Snake River Plain Aquifer is approximately 177 m (580 ft) beneath the RWMC. Elevated concentrations of carbon tetrachloride (CCl₄) were detected in shallow soil gas above several of the pits, indicating that volatile organic compounds (VOCs) had migrated in the vapor phase from the source pits into shallow soils at the SDA. The rate of vapor discharge to the atmosphere was measured using a surface flux chamber. Vapor port monitoring wells were used to characterize the nature and extent of contamination in the vadose zone. Data from vapor port monitoring indicated that contamination had migrated laterally as far as 914 m (3,000 ft) beyond the SDA boundary.

The RI/FS evaluated site risks including human health and environmental concerns. It determined that releases from the site present an imminent risk to public health, welfare, or the environment.

Remedial alternatives were developed and analyzed in detail to evaluate their protectiveness of human health and the environment. The primary objective was to prevent vapor phase contaminants in the vadose zone from reaching the groundwater in concentrations that would result in future concentrations that exceed maximum contaminant levels.

The four alternatives evaluated included: (1) no action, (2) containment by capping, (3) extraction/treatment by vapor vacuum extraction, and (4) extraction/treatment by vapor vacuum extraction with vaporization enhancement. A comparative analysis of the alternatives was completed, and ultimately extraction with treatment was selected and deployed.

A treatability study was conducted at the SDA in 1993 to determine the effectiveness of the vapor vacuum extraction process in removal of contaminants from the vadose zone. This test indicated that the extraction system was effective in reducing contaminant concentrations in vapor monitoring wells as much as 137 m (450 ft) from the extraction well.

Operable Unit 7-08, Organic Contamination in the Vadose Zone (OCVZ), extends from the land surface to the top of the Snake River Plain Aquifer approximately 177 m (580 ft) beneath the RWMC excluding the SDA disposal pits and trenches. The vadose zone contains VOCs primarily in the form of organic vapors that have migrated from the buried waste in the SDA pits.

Operable Unit 7-08 is the designation recognized under the *Federal Facility Agreement and Consent Order* (DOE-ID 1991) and the “Comprehensive Environmental Response Compensation and Liability Act” (42 USC § 9601 et seq., 1980) for OCVZ remediation beneath the RWMC. The remediation is being performed in accordance with the OU 7-08 ROD signed in 1994 (DOE-ID 1994).

On January 11, 1996, VVET Units A, B, and C were started, and Phase I of remediation of OCVZ began. Originally, extraction was to be conducted in three 2-year phases. The intent was to operate the system for 2 years, evaluate the performance of the system, and make modifications and improvements as necessary. Phase I lasted 2 years according to the original schedule from January 1996 through January 1998. Phase II, currently projected to end no later than 2018, began in January 1998 and will continue until active vapor extraction is no longer required to ensure that the remedial action objectives (RAOs) will be met (INEEL 2005). Phase III is scheduled to begin immediately after Phase II ends and will continue for at least 1 year, terminating as early as 2019. Though progress has been made in achieving cleanup goals, the original schedule appears to have been overly optimistic, necessitating an extension of duration for Phases II and III. The primary reasons for the extensions are: (1) the VOC source areas may still be active and contributing mass to the vadose zone, (2) there may be a large reservoir of VOC mass in the subsurface material, or (3) a combination of 1 and 2. These are discussed in more detail later in this report.

The first phase of the RA is documented in the *Final Phase I Remedial Action Report for Organic Contamination in the Vadose Zone Operable Unit 7-08* report (Higgins 1997). Remediation activities completed between the start of Phase II in January 1998 and July 1999 are documented in the *Interim Phase II Remedial Action Report for Organic Contamination in the Vadose Zone Operable Unit 7-08* (INEEL 1999). Phase II remediation activities completed between July 1999 and December 2001 are documented in the *Interim Remedial Action Report for the OU 7-08 Organic Contamination in the Vadose Zone Project* (Sondrup, McMurtrey, and Harvego 2003). This remedial action status report documents RA Phase II activities conducted between January 2002 and June 2005. The remediation activities are being performed in accordance with the OU 7-08 *Remedial Design/Remedial Action Work Plan* (Sciencetech 1995).

1.3 History of RWMC and Chronology of Events

The RWMC is located in the southwest portion of the INL and was established in 1952 as a disposal site for solid low-level radioactive waste generated by the INL and other U.S. Department of Energy (DOE) operations. It encompasses approximately 704,178 m² (174 acres) and consists of three main areas: (1) the SDA, (2) the Transuranic Storage Area, and (3) an administrative area. Figures 1 and 2 are maps showing the locations of the RWMC at the INL and the SDA within the RWMC, respectively.

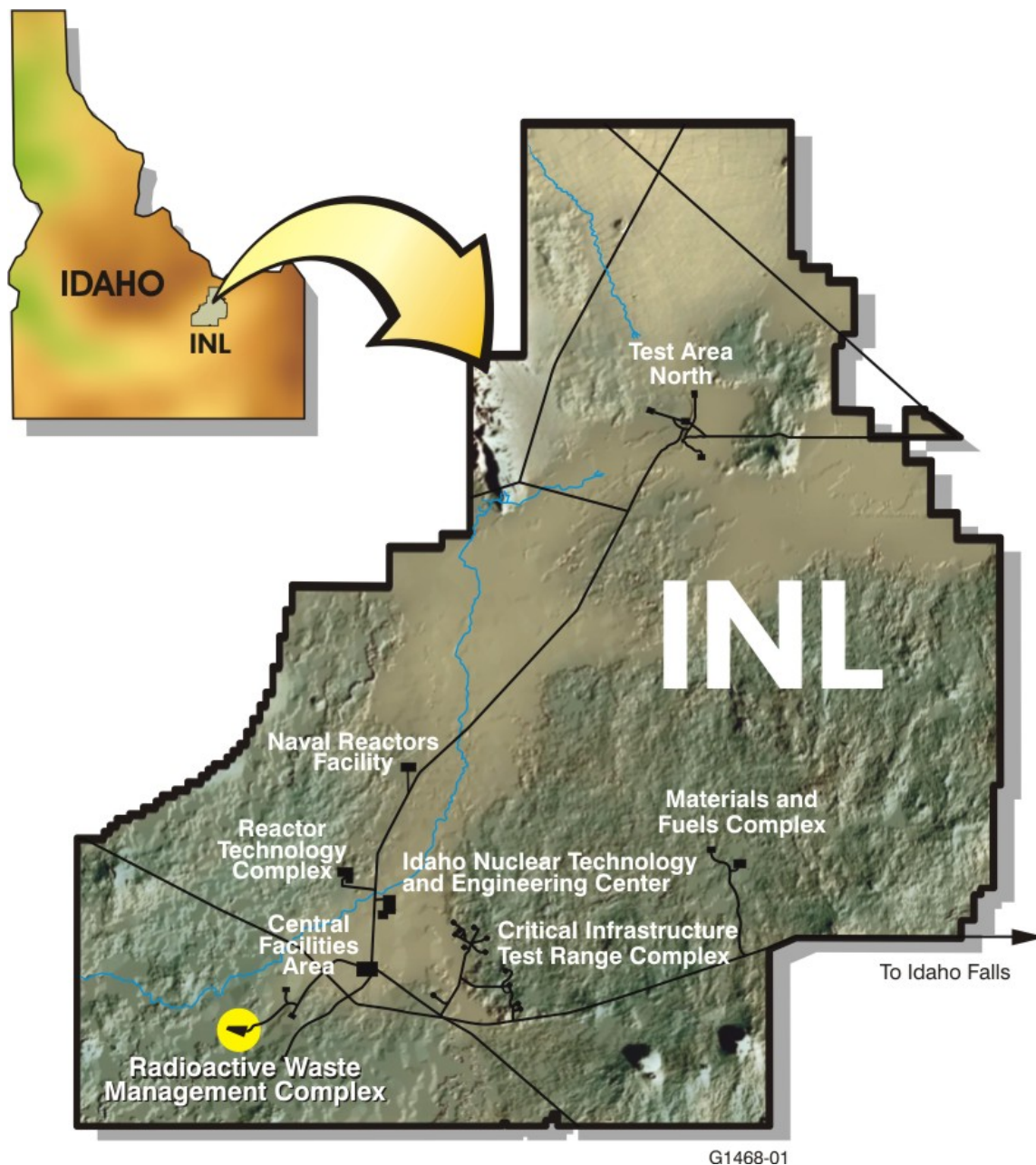
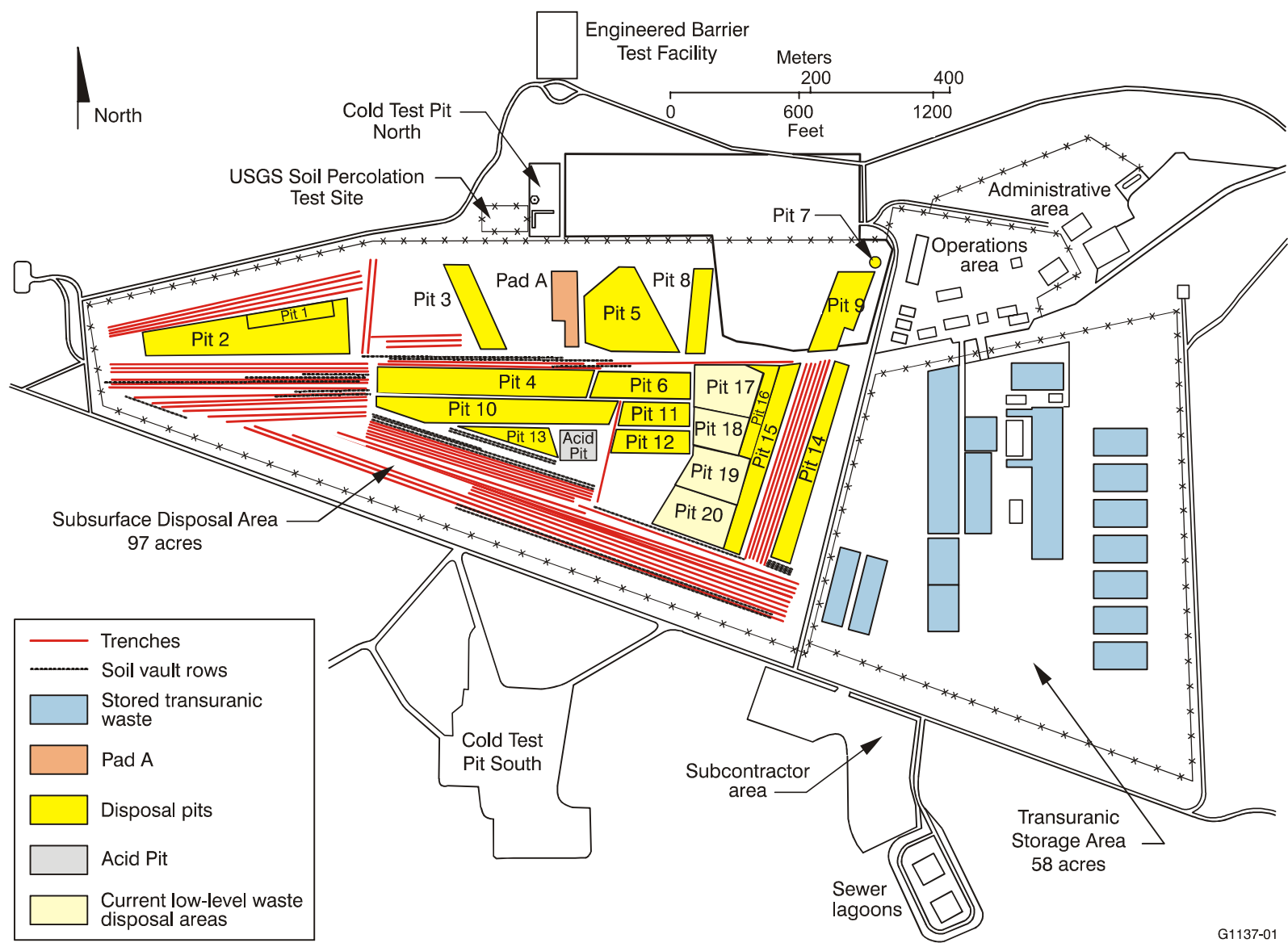


Figure 1. Map of the Idaho National Laboratory Site showing the location of major facilities.



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Figure 2. Map of the Radioactive Waste Management Complex showing the location of the Subsurface Disposal Area.

The SDA comprises individual storage and disposal areas consisting of pits, trenches, aboveground storage pads, and soil vaults. The presence of organic contaminants in the vadose zone beneath the RWMC resulted from the burial and subsequent breach of containerized organic waste, primarily from the Rocky Flats Plant,^a in several of the pits and trenches. The organic waste was mixed with calcium silicate to reduce free liquids and form a very thick grease-like material, which was typically double bagged and placed in drums before disposal. In addition, small amounts of absorbent, such as Oil-Dri, were normally mixed with the waste to bind any remaining free liquids. The organic waste consisted of lathe coolant, used oils, and degreasing agents such as CCl₄; 1,1,1-trichloroethane (TCA); trichloroethene (TCE); tetrachloroethene (PCE); hydraulic oil; gearbox oil; spindle oil; Freon; and Varsol (Clements 1982). The containers have deteriorated over time, allowing VOC contaminants to migrate into the vadose zone. The vadose zone has subsequently become contaminated with VOCs, and trace levels of CCl₄ have been detected in the underlying Snake River Plain Aquifer.

1.3.1 Chronology of Vapor Extraction and Monitoring Wells

Several monitoring wells had been installed in and around the SDA prior to the treatability study to assist in tracking VOC behavior in the vadose zone. To implement the selected remedy described in the OU 7-08 ROD (DOE-ID 1994), 15 new vapor extraction and monitoring wells were installed in or next to the SDA during 1994. In addition, one existing extraction well (i.e., 8901D) and six existing monitoring wells (i.e., D02, 8801, 8902, 9301, 9302 and USGS-118) were incorporated for monitoring VOC vapors.

In 2000, Wells DE-1 and M17S were installed to provide additional monitoring. Wells 6E and 7E were installed in more strategic locations and provide added extraction capability at shallow depths.

Fourteen new wells were installed to support the OU 7-08 remedial action between October 2002 and March 2003. These wells were completed as vapor extraction wells or as combination monitoring and extraction wells. The locations of the wells are shown in Figure 3. They were installed in clusters of three wells, one well having a shallow extraction (SE) interval located above the B-C interbed (i.e., ~34 m or 110 ft bls), one well having an intermediate extraction (IE) interval located between the B-C interbed (i.e., ~34 m or 110 ft bls) and the C-D interbed (i.e., ~73 m or 240 ft bls), and one well having a deep extraction (DE) interval located below the C-D interbed (i.e., ~73 m or 240 ft bls). The new wells, SE3, IE3, DE3, IE4, DE4, SE6, IE6, DE6, SE7, IE7, DE7, SE8, IE8, and DE8, were installed in five distinct locations based primarily on proximity to buried organic waste. An existing well (7E) was used as the shallow extraction well near Wells IE4 and DE4. Additionally, Wells M10SR and 1898 were installed with vapor ports during 2003.

In 2005, two wells, 8801 and 9302, were capped to accommodate the expansion of the Accelerated Retrieval Project (ARP). The current total of active monitoring wells is 57, with 168 vapor ports being routinely monitored.

1.3.2 Chronology of Vapor Vacuum Extraction Units

To implement the selected remedy described in the OU 7-08 *Record of Decision* (DOE-ID 1994), three VVET units with recuperative flameless thermal-oxidation systems were installed within the boundaries of the SDA and began operating in January 1996. Two of the flameless thermal-oxidation-system units (designated as Units A and B) extracted and treated vapors from two extraction wells, and one flameless thermal-oxidation-system unit (designated as Unit C) extracted and

a. The Rocky Flats Plant is located 26 km (16 mi) northwest of Denver. In the mid-1990s, it was renamed the Rocky Flats Environmental Technology Site. In the late 1990s, it was again renamed to its present name, the Rocky Flats Plant Closure Project.

treated vapors from one extraction well. During the spring of 2001, Unit C was decommissioned and removed from the SDA. Unit D, an electrically heated catalytic oxidizer, was installed at the previous Unit C location. In February 2003, Unit B was decommissioned, followed by Unit A in October 2003. Units E and F, both electrically heated catalytic oxidizers, have replaced Units A and B and became operational in spring 2004.

The VVET Unit E and the associated extraction wells and piping were located within the foundation boundary of the ARP Phase II Retrieval Enclosure. During the spring of 2005, Unit E, the 300-kVA transformer power supply to Unit E, and the piping and associated instrumentation and controls needed to connect Unit E to the existing extraction wells were relocated. Figure 3 shows VVET Units and extraction well lines after relocation of Unit E, and Figure 4 shows the location of the ARP Phase I Retrieval Enclosure.

Three catalytic oxidizers, Units D, E, and F, are currently in operation and extract vapors from up to 18 wells.

1.4 Future Site Use and Cleanup Goals

The OU 7-08 RI/FS (Duncan, Troutman, and Sondrup 1993) indicates that the anticipated future use of the SDA site is unrestricted residential. Since that time, the *Second Addendum to the Work Plan for the OU 7-13/14 Waste Area Group 7 Comprehensive Remedial Investigation/Feasibility Study* (Holdren and Broomfield 2002) has redefined future land use. Land use from 2010 through 2109 assumes RWMC will be limited to industrial applications with active institutional controls for at least 100 years after remediation. Exposure scenarios assume current residential use at the INL boundary (for groundwater use only) and occupational use within the current RWMC boundary (for inhalation, external exposure, and soil ingestion). After 2109, the land use inside the RWMC will remain nonresidential with passive institutional controls and residential at the current RWMC boundary. For the purposes of this report, and until OU 7-08 is incorporated into the OU 7-13/14 ROD, the OCVZ RAOs will remain the same. If the site were to be developed for unrestricted use, air and water quality must be maintained at levels protective of human health for all potential exposure pathways. To achieve this level of protection, the OCVZ RAOs are structured around vadose zone VOC concentrations that will prevent VOC concentrations in the groundwater from exceeding maximum contaminant levels at the end of the 100-year institutional control period. Remedial action objectives also include preliminary remediation goals that are based on both risk and frequently used standards (i.e., applicable or relevant and appropriate requirements) and that are typically expressed as contaminant cleanup levels to be achieved. The original preliminary remediation goals, as identified in the ROD (DOE-ID 1994), were developed for the shallow vadose zone (above 73-m [240-ft] C-D interbed) using the PORFLOW simulation code and a relatively simplistic model. Since the ROD was issued, a more robust, multidimensional, multiphase model using the TETRAD simulation code has been developed to simulate organic contaminant migration in the SDA subsurface. New remediation goals have been developed using the TETRAD model for each of the regions identified in the *OU 7-08 Data Quality Objectives Summary Report* (INEEL 2005).

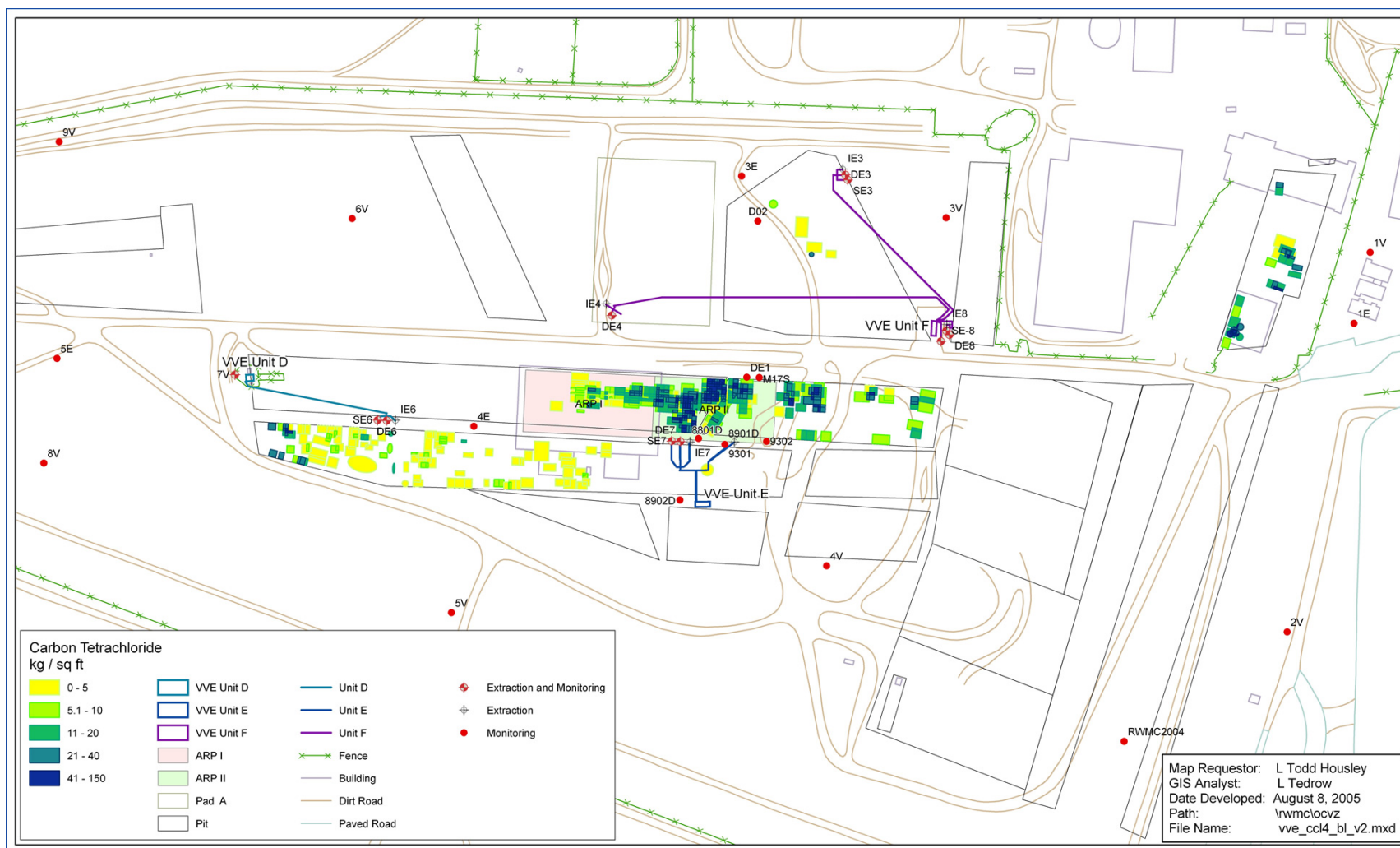


Figure 3. VVET system, extraction and monitoring well locations, and VOC burial locations.

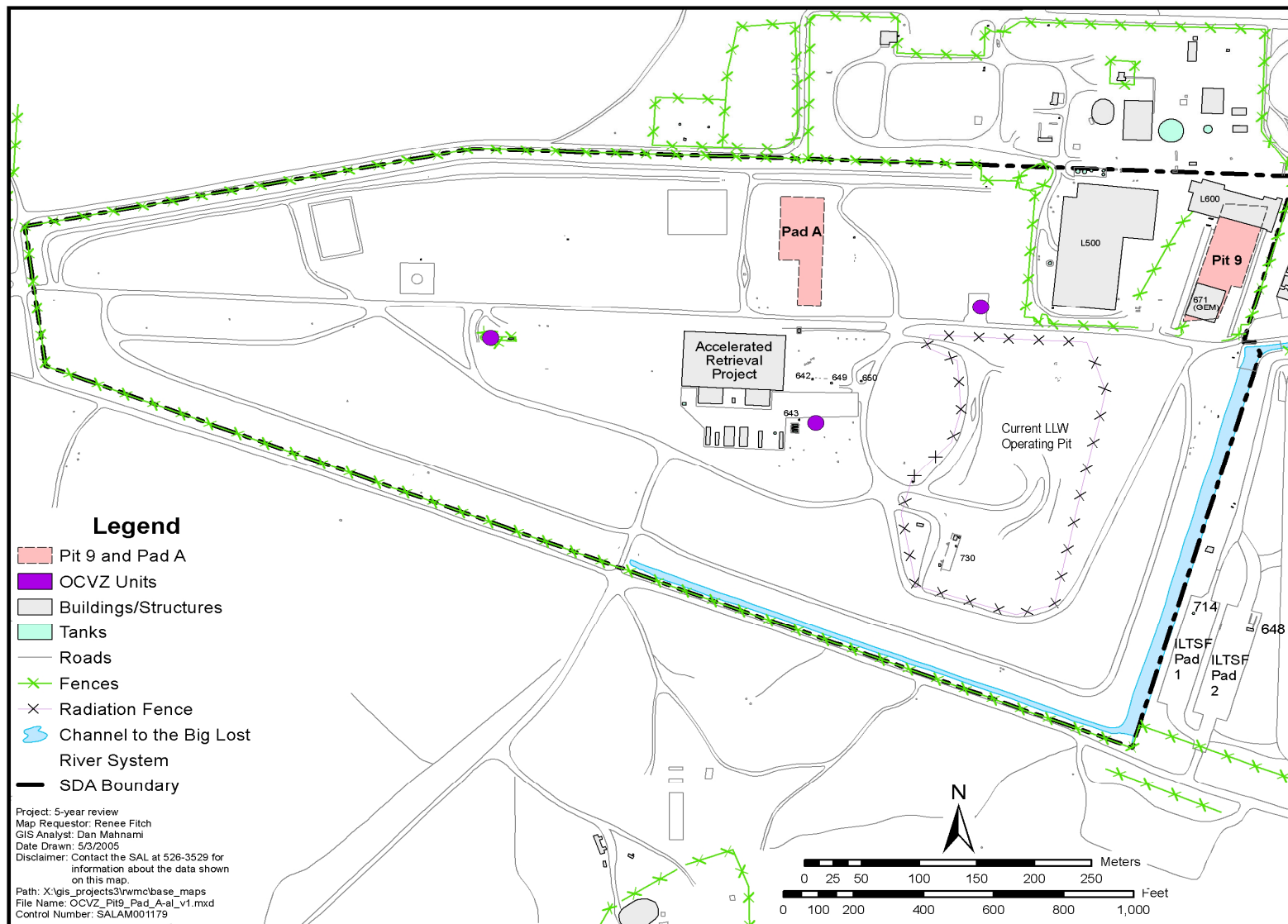


Figure 4. Location of VVET units and ARP Phase I Retrieval Enclosure.

2. REMEDIATION ACTIVITIES

The OCVZ remedial action consists of several activities, including system operations, occupational and operational sampling, and environmental sampling and reporting. These activities are discussed in detail in the following sections.

2.1 System Operations

Three catalytic oxidizers, Units D, E, and F, are currently in operation and extracting vapors from the subsurface at the SDA. System technicians and engineers maintain and monitor VVET unit operations during the 4-day, 10-hour/day workweek. The technicians schedule and oversee routine maintenance, collect influent samples, complete operations logs and reports, and perform troubleshooting activities when necessary. A block diagram for the catalytic oxidizers is shown in Figure 5.

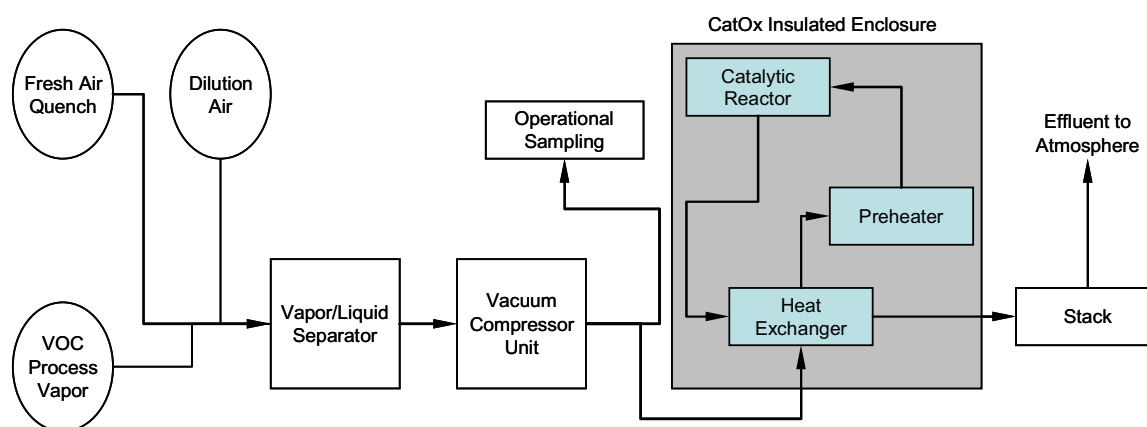


Figure 5. Block diagram of catalytic oxidation system.

Since startup of the VVET system in January 1996 through June 30, 2005, the VVET units have operated for a combined total of 131,064 hours (Housley 2005). The operating schedule is shown in Table 1.

Table 1. Cumulative operational times of the vapor vacuum extraction with treatment system.

Operating Period	Unit A	Unit B	Unit C	Unit D	Unit E	Unit F	Notes
1996							
Hours Operated	3,323	2,683	2,465	N/A	N/A	N/A	
Calendar Hours	8,489	7,647	8,169	N/A	N/A	N/A	
Percent Operated	39%	35%	30%	—	—	—	
1997							
Hours Operated	4,562	4,595	2,511	N/A	N/A	N/A	
Calendar Hours	8,760	8,760	8,760	N/A	N/A	N/A	
Percent Operated	52%	52%	29%	—	—	—	
1998							
Hours Operated	6,587	6,247	N/A	N/A	N/A	N/A	

Table 1. (continued).

Operating Period	Unit A	Unit B	Unit C	Unit D	Unit E	Unit F	Notes
Calendar Hours	8,760	8,760	8,760	N/A	N/A	N/A	
Percent Operated	75%	71%	—	—	—	—	
1999							
Hours Operated	6,197	2,744	2,276	N/A	N/A	N/A	
Calendar Hours	8,760	8,760	8,760	N/A	N/A	N/A	
Percent Operated	71%	31%	26%	—	—	—	
2000							
Hours Operated	6,047	3,292	1,995	N/A	N/A	N/A	Unit C failed in spring 2000
Calendar Hours	8,760	8,760	3,609.2	N/A	N/A	N/A	
Percent Operated	69%	38%	55%	—	—	—	
2001							
Hours Operated	5,489	4,335	N/A	752	N/A	N/A	Unit C replaced with Unit D in spring 2001
Calendar Hours	8,760	8,760	N/A	1,970	N/A	N/A	
Percent Operated	63%	49%	—	19%	—	—	Unit D shakedown period
2002							
Hours Operated	6,810	7,175	N/A	7,122	N/A	N/A	Unit D shakedown completed 3/4/02
Calendar Hours	8,760	8,760	N/A	8,760	N/A	N/A	
Percent Operated	78%	82%	—	81%	—	—	
2003							
Hours Operated	5,519	710	N/A	6,624	N/A	N/A	Unit B shutdown in February 2003
Calendar Hours	6,417	1,018.2	N/A	8,760	N/A	N/A	Unit A shutdown in September 2003
Percent Operated	86%	70%	—	76%	—	—	
2004							
Hours Operated	N/A	N/A	N/A	8,150	6,396	5,478	Unit F started in March 2004
Calendar Hours	N/A	N/A	N/A	8,784	6,480	6,992	Unit E started in April 2004
Percent Operated	—	—	—	93%	99%	78%	
2005							
Hours Operated	N/A	N/A	N/A	3,994	3,117	3,867	Through June 30, 2005
Calendar Hours	N/A	N/A	N/A	4,344	4,344	4,344	
Percent Operated	—	—	—	92%	72%	89%	
TOTALS							
Hours Operated	44,535	31,780	9,248	26,643	9,513	9,345	
Calendar Hours	67,466	61,225	38,058	32,618	10,824	11,336	
Percent Operated	66%	58%	24%	82%	88%	82%	

2.2 Occupational and Operational Sampling

Five methods were used to monitor worker exposure to occupational hazards and the efficiency of unit operations. Included in these were industrial hygienist monitoring for VOCs and acid gas, noise level monitoring, VVET stack sampling, VVET inlet radiological filter sampling, and Fourier transform infrared (FTIR) spectrometry sampling. Monitoring was conducted at various dates and locations in the SDA as described in the following sections.

2.2.1 Industrial Hygiene Monitoring

Industrial hygienic monitoring for six VOCs (i.e., CCl₄, PCE, TCA, 1,1,2-trichloroethane, CHCl₃, and methylene chloride) was performed on the inside of the VVET units and for acid gas (i.e., hydrogen fluoride and hydrogen chloride) levels outside of the VVET units. The inside of each unit was monitored on July 28, 2004. The outside monitoring was done on separate dates for each unit. Unit E on August 18, Unit D on August 19, and Unit F on August 26, 2004. Results showed that each constituent monitored was present in concentrations less than the minimum reporting limit.

2.2.2 Noise Level Monitoring

Industrial hygienists performed a sampling of noise levels at VVET Units E and F in May 2004. The VVET units were in normal operating modes at the time of the surveys. Table 2 is a record of the data collected.

Table 2. Noise level data from vapor vacuum extraction with treatment Units E and F.

Area	VVET Unit E	VVET Unit F
4.5 m or 15 ft W of unit (outside)	70 to 72 dBA	49 to 51 dBA
4.5 m or 15 ft N of unit (outside)	53 to 57 dBA	48 to 50 dBA
4.5 m or 15 ft E of unit (outside)	59 to 51 dBA (68 to 70 motor fan cycling)	52 to 56 dBA (62 to 64 motor fan cycling)
4.5 m or 15 ft S of unit (outside)	54 to 56 dBA	49 to 51 dBA
Inside (SE) half of unit	74 to 78 dBA	76 to 78 dBA
Inside (SW) half of unit	75 to 77 dBA	77 to 79 dBA
Between fan and motor	81 to 83 dBA	83 to 85 dBA

Findings of the sampling included the following:

- Information from operations indicate that when the unit is drawing and when the wells are changed, the rpm of the unit increases. This in turn increases the noise levels slightly inside the units. When the air conditioning/heater units turn on, noise on the outside increases by about 10 dBA.
- Traffic increases the background noise on the outside of the units by about 10 to 15 dBA.
- Unit E had more variable frequency noises within the unit, which may have been attributed to equipment draw and motor rpm.

- The area where the VVET units are located is controlled. Only authorized personnel should go into the units and the exposures are short.

Ultimately, it was found that noise levels do not exceed those set in OSHA (29 CFR 1910)/ACGIH (2005) (i.e., 8-hour time-weighted average of 85 dBA), nor the posting requirements. Noise levels may increase slightly because of increased rpm and draw through the lines, but not in quantities that would exceed the time-weighted average.

2.2.3 Stack Emissions Sampling

The concentrations of C-14 and H-3 in the stack gas of the VVET units are measured periodically for compliance with 40 CFR 61, Subpart H, “National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities.” Stack sampling results during 2004 were documented in an Interoffice Memorandum from P. D. Ritter to L. A. Harvego on December 6, 2004, which is contained in the report *Environmental and Operational End-Year Data Report for the OU 7-08 Organic Contamination in the Vadose Zone Project - 2004* (Housley 2005), Appendix G, Results of Stack Sampling from Vapor Vacuum Extraction Units D, E, and F During 2004 for NESHAP Reporting, PDR-05-04.

2.2.4 Radiological Filter Sampling and Analysis at the Inlet to Vapor Vacuum Extraction with Treatment Units

Weekly radiological surveys are completed on inlet filters downstream of the blowers at each of the VVET units. No radiological contamination has been found on the filters.

2.2.5 FTIR Emissions Monitoring

The Fourier transform infrared (FTIR) spectrometer is capable of measuring the inlet and exhaust gas compositions from the VVET oxidizers. This activity provides a metric by which the performance of the catalytic oxidizer in destruction of VOCs can be measured. Empirical data generated through this activity is used to calculate input data to the VVET emissions air dispersion model.

The extractive FTIR instrument is capable of analyzing the contaminants of interest in a wide range of concentrations. The FTIR instrument is an integral feature in a manifold configured with solenoid valves in order to provide automated stream selection of samples from either the inlet or outlet of the VVET system and from standard gas or blank streams. The destruction efficiency performance of each unit is excellent, exceeding established destruction efficiency baseline goals. Detailed results of the FTIR sampling and analysis are contained in a separate document (EDF-6082).

2.3 Environmental Sampling of Monitoring Wells and Reporting

Data from representative monitoring well vapor samples are used to assess the effectiveness of the OCVZ remedy. Fifty-nine vapor monitoring wells within and next to the SDA have been used for monitoring purposes during remedial action operations. Each well has from one to nine vapor ports (not all of which are sampled), ranging in depth from 9.9 to 174.7 m (32.5 to 573 ft) below land surface. Table 3 is a list of all the wells used for sampling and/or extraction by OU 7-08. The depths of regularly monitored vapor ports are shown in Figure 6.

Samples have been routinely collected from 141 vapor ports at the vapor monitoring wells. An additional 33 ports outside the SDA boundary are used to monitor the vapor concentrations at various locations ranging up to 2,774 m (9,100 ft) from the VOC source area at quarterly intervals. Due to the

ARP facility infrastructure, Wells 8801 and 9302, each containing three regularly monitored vapor ports, have been temporarily capped. Vapor port sampling and analysis are completed in accordance with the OU 7-08 *Data Quality Objectives Summary Report* (INEEL 2005). Sampling precision, accuracy, completeness, comparability, and the results of the environmental sampling are included in semiannual data reports.

The results of the environmental sampling indicate that concentrations have decreased substantially within the remedial action zone of influence.

Table 3. Wells installed or used currently by OU 7-08 for monitoring and/or extraction.

Well Name	Well Type
77-1, 78-4, WWW-1, USGS-118	Existing wells adapted for use as vapor sampling wells and located outside the SDA
DO2, 8902, RWMC-2004	Vapor monitoring wells with permanent sampling ports inside the SDA
8901, 7E, SE3, SE4, SE6, SE7, SE8	Vapor extraction wells inside the SDA
2E, 7V, IE3, IE4, IE6, IE8, DE3, DE4, DE6, DE8, 1E, 3E, 4E, 5E, 1V, 2V, 3V, 4V, 5V, 6V, 8V, 9V, 10V	Vapor extraction and monitoring wells inside the SDA
M17S	Groundwater monitoring well with permanent vapor sampling port inside the SDA (modified existing ports to route outside the ARP Retrieval Enclosure)
VVE-1, VVE-3, VVE-4, VVE-6, VVE-7, VVE-10, OCVZ-11, OCVZ-13, OCVZ-14	Vapor monitoring wells with permanent vapor sampling ports outside the SDA
M1S, M3S, M4D, M6S, M7S, M10S, M10SR, M11S, M13S, M14S, M15S, M16S, 1898	Groundwater monitoring wells with permanent vapor sampling ports outside the SDA
8801, 9302	Vapor monitoring wells that were capped to allow for expansion of ARP (monitoring of these wells will resume following D&D of ARP Retrieval Enclosure)
DE7, IE7	Vapor extraction well and monitoring ports (modified existing ports and extraction line to route outside the ARP Retrieval Enclosure)
9301, DE1, 6E	Vapor monitoring well (modified vapor ports to route outside the ARP Retrieval Enclosure to continue vapor monitoring during ARP retrieval activities)

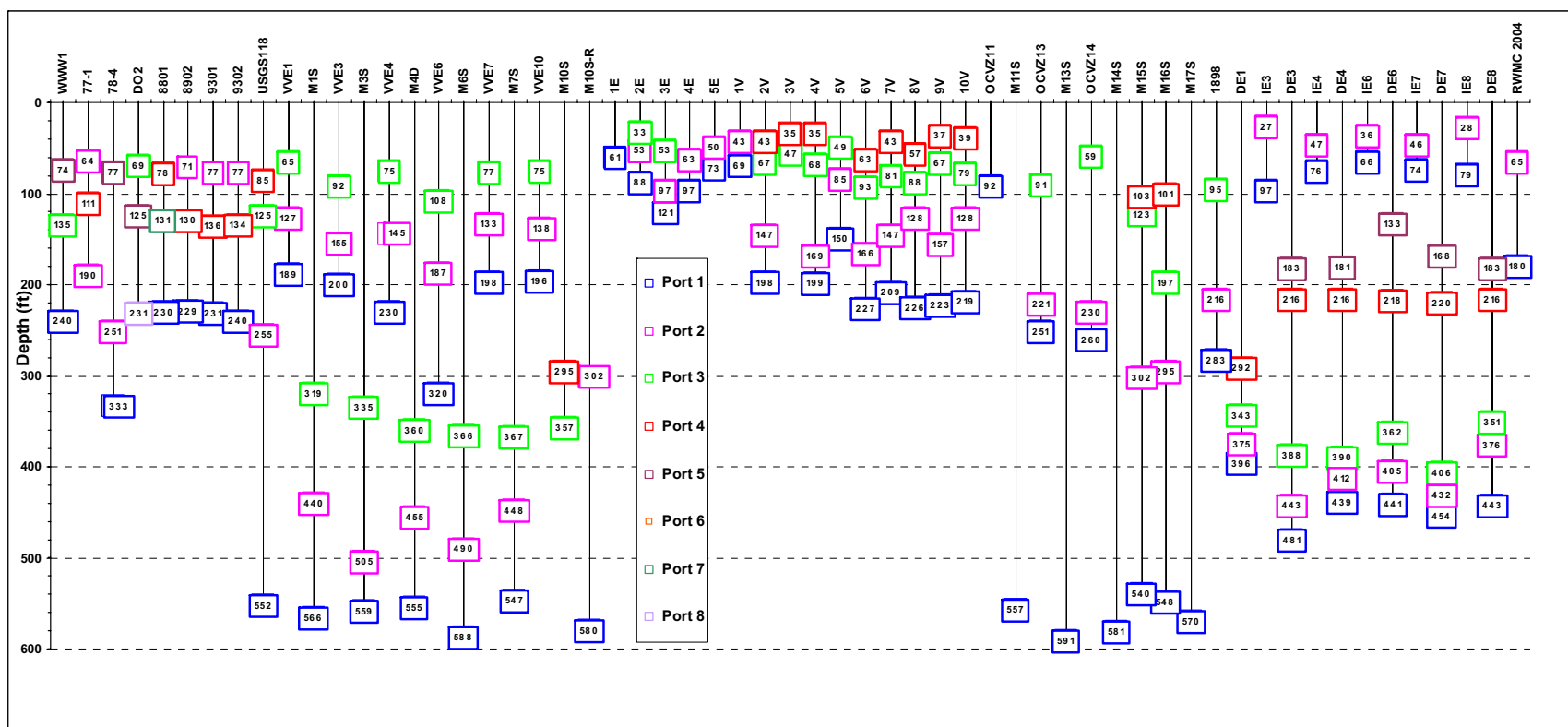


Figure 6. Depths of monitoring wells sampled by OU 7-08.

3. EVALUATION OF VAPOR EXTRACTION AND MONITORING DATA

An evaluation of vapor extraction and soil-vapor monitoring data was conducted to understand the impact and effectiveness of past OU 7-08 remediation activities. The evaluation is anticipated to lead to more efficient strategies for removing organic contamination from the vadose zone and to help meet project objectives outlined in the OU 7-08 ROD (DOE-ID 1994).

3.1 Trends in Mass Removal

3.1.1 Mass Removed

One of the performance measures used to gauge the effectiveness of operations is VOC mass removal. Samples are collected from the inlet of each of the VVET units and are analyzed using a Brüel and Kjaer Photoacoustic Gas Analyzer, Model 1302. The detected contaminant concentrations are used in conjunction with system flow rates and operational run time to estimate the cumulative VOC mass removal. Samples are collected and analyzed in accordance with the OU 7-08 *Data Quality Objectives Summary Report* (INEEL 2005).

Figure 7 shows the mass removed per year for the entire VVET system through 2004. The data indicate that in 2004, 18,600 kg (41,000 lb) of VOCs were removed. This is approximately twice as much as was removed in all the other years with the exception of 2002 at 13,029 kg (28,723 lb). The least amount of mass removed was 5,625 kg (12,400 lb) in year 2000. The exceptionally large amount of mass removed in 2004 is due primarily to three factors: (1) the three new catalytic oxidizer units (D, E, and F) were operating for most of 2004, (2) many of the new extraction wells which began being used in 2004 are located in more highly concentrated areas of the plume, and (3) units were not operating for much of 2003 while Units A and B were being replaced by Units E and F. During this time, concentrations rebounded to much higher levels. Similarly, the large amount of mass removed in 2002 can be attributed to all three units (A, B, and D) being up for most of the year, while Units B and C were down for a good portion of 2000 and 2001 due to mechanical failures. The relatively small amount of mass removed in 1996 is likely due to the scheduled downtime for rebounds and downtime due to mechanical difficulties.

As of June 30, 2005, the total mass of VOCs removed and treated in the oxidizers is 91,500 kg (202,000 lb). This total includes 55,100 kg (122,000 lb) of CCl₄, 14,000 kg (30,700 lb) of TCE, 4,800 kg (10,700 lb) of TCA, 3,770 kg (8,300 lb) of PCE, and 13,900 kg (30,600 lb) of CHCl₃.

The analyte mass contribution to total VOC mass from all operational cycles through June 30, 2005, for the five analytes of concern, including CHCl₃; TCA; PCE; TCE; and CCl₄ is depicted in Figure 8. Table 4 shows the mass removed of each analyte per year.

3.1.2 Mass Removal Rate

The efficiency of the VVET system can be examined by looking at the mass removed per hour of operation (see Figure 9). The most notable features on the removal rate plot are (1) the decreasing trend in the mass removal rate during the first 5 years of operation from 1996 through 2000, and (2) the large increase in removal rates in 2001 and 2004.

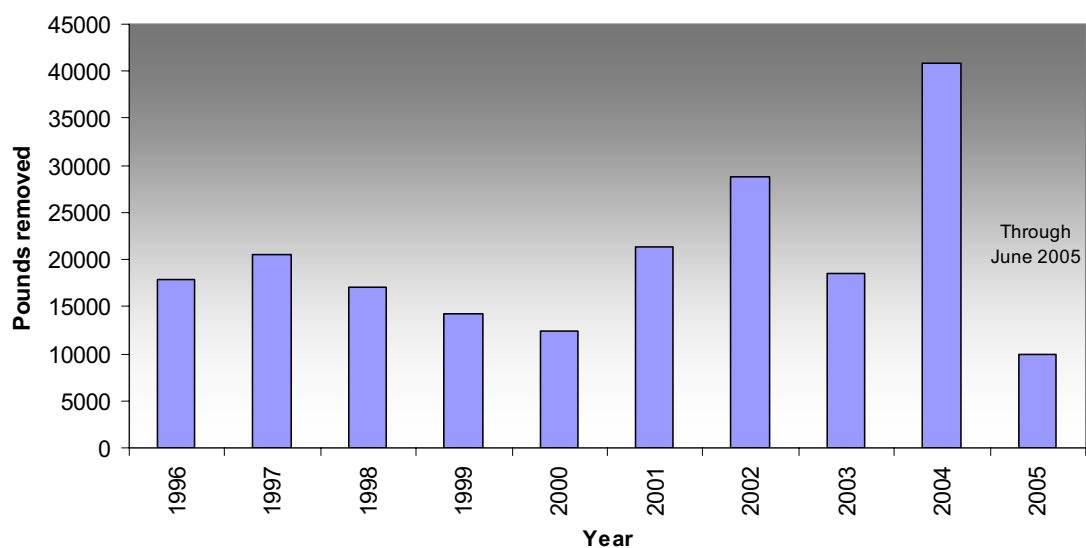


Figure 7. VOC mass removed annually through June 2005 by the VVET system.

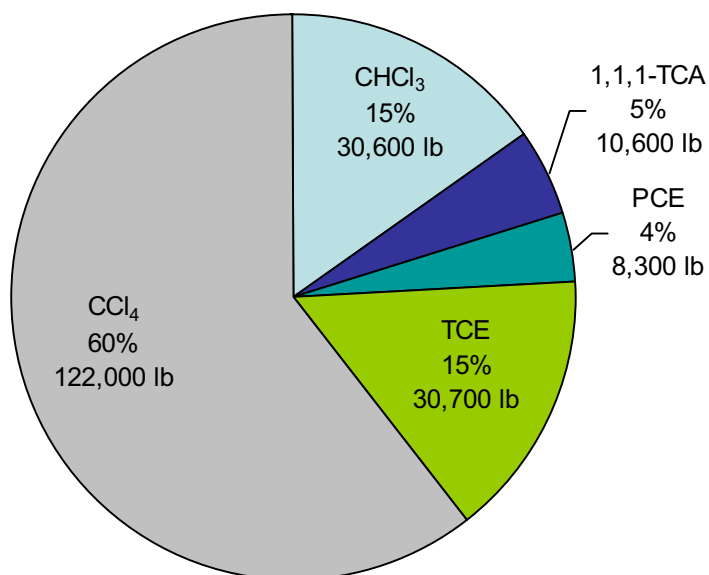


Figure 8. Analyte mass contribution to total volatile organic compound mass from 1996–June 2005.

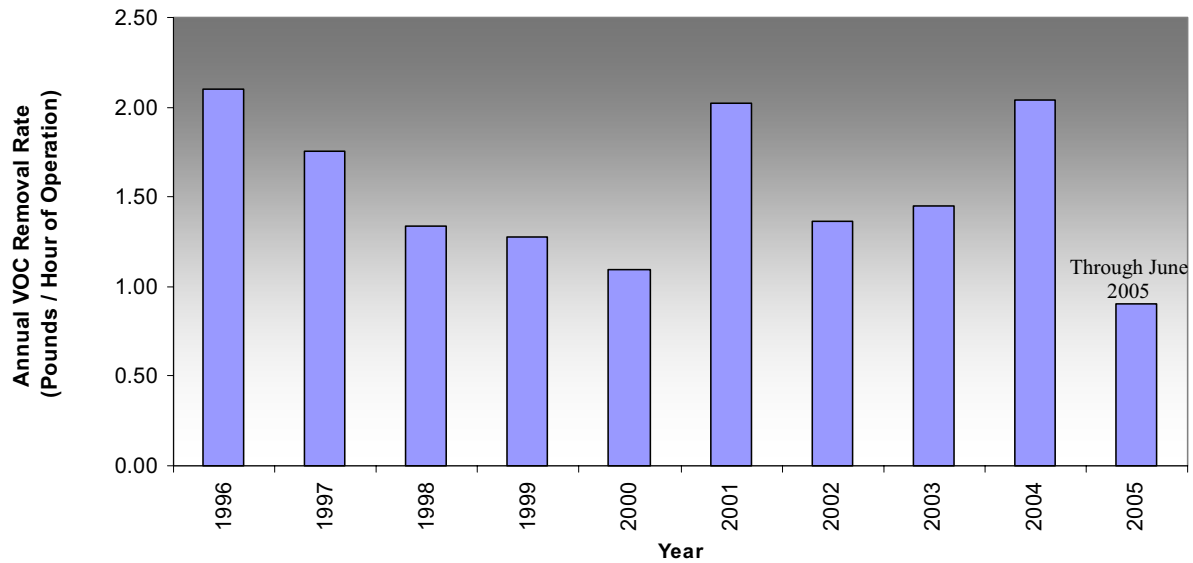


Figure 9. VVET system annual VOC mass removal rates (lb/hr).

Table 4. Breakdown per operating cycle of the mass of VOCs removed through June 2005.

Operating Period	Year	CHCl ₃ (lb)	TCA (lb)	PCE (lb)	TCE (lb)	CCl ₄ (lb)	Total (lb)
1st 8 weeks	1996	1,001	277	183	855	4,447	6,763
% of total		15%	4%	3%	13%	66%	
2nd 8 weeks	1996	671	209	168	646	3,090	4,784
% of total		14%	4%	4%	14%	65%	
3rd 8 weeks	1996	501	149	104	449	2,211	3,413
% of total		15%	4%	3%	13%	65%	
1st quarter	1997	443	108	62	320	1,938	2,871
% of total		15%	4%	2%	11%	68%	
2nd quarter	1997	1,078	360	294	1,076	5,191	7,999
% of total		13%	5%	4%	13%	65%	

Table 4. (continued).

Operating Period	Year	CHCl ₃ (lb)	TCA (lb)	PCE (lb)	TCE (lb)	CCl ₄ (lb)	Total (lb)
3rd quarter	1997	643	119	145	604	2,800	4,311
% of total		15%	3%	3%	14%	65%	
4th quarter	1997	1,202	342	241	987	5,391	8,162
% of total		15%	4%	3%	12%	66%	
Midyear	1998	1,083	339	247	967	4,757	7,393
% of total		15%	5%	3%	13%	64%	
End-Year	1998	1,452	376	412	1,537	5,942	9,719
% of total		15%	4%	4%	16%	61%	
Midyear	1999	745	196	149	808	3,725	5,622
% of total		13%	3%	3%	14%	66%	
End-Year	1999	1,149	367	320	1,337	5,492	8,664
% of total		13%	4%	4%	15%	63%	
Midyear	2000	1,125	302	272	1,252	5,119	8,072
% of total		14%	4%	3%	16%	63%	
End-Year	2000	630	128	69	567	2,934	4,329
% of total		15%	3%	2%	13%	68%	
Midyear	2001	1,534	272	326	1,349	6,153	9,634
% of total		16%	3%	3%	14%	64%	
End-Year	2001	1,720	513	332	1,849	7,349	11,763
% of total		15%	4%	3%	16%	62%	
Midyear	2002	2,061	966	517	2,377	7,845	13,767

Table 4. (continued).

Operating Period	Year	CHCl ₃ (lb)	TCA (lb)	PCE (lb)	TCE (lb)	CCl ₄ (lb)	Total (lb)
% of total		15%	7%	4%	17%	57%	
End-Year	2002	2,412	1,016	535	2,516	8,477	14,956
% of total		16%	7%	4%	17%	57%	
Midyear	2003	2,134	975	603	2,379	8,151	14,242
% of total		15%	7%	4%	17%	57%	
End-Year	2003	765	290	164	740	2,388	4,347
% of total		18%	7%	4%	17%	55%	
Midyear	2004	3,495	1,384	745	3,505	12,356	21,486
% of total		16%	6%	3%	16%	58%	
End-Year	2004	3,180	1,230	1,062	3,042	10,919	19,433
% of total		16%	6%	5%	16%	56%	
Midyear	2005	1,566	688	1,359	1,544	4,780	9,936
% of total		16%	7%	14%	16%	48%	
Total 1996–June 2005							201,667
CCl ₄ = carbon tetrachloride CHCl ₃ = chloroform PCE = tetrachloroethene TCA = 1,1,1-trichloroethane TCE = trichloroethene							

It is common for the mass removal rate to decline over time as the most accessible contamination is removed first. It is to be expected that the highest removal rate should take place in the first year of operations, but it is noteworthy that the operating procedure was different in 1996 than any other year. Operations were conducted in 8-week cycles, separated by 2-week rebound periods (downtime). The concept of shutting down and allowing concentrations to rebound is more efficient in terms of the mass removed per hour of operation, but it does not maximize mass removal. Beginning in 1997, the operating strategy shifted from 8-week cycles to continuous operation. Mechanical problems caused the units to go down frequently and the project endeavored to operate the units as continuously as possible.

In 2001, after 5 years of expectedly declining VOC removal rates, the rate of removal increased to nearly the level of 1996. The reason for the large increase in the mass removal rate in 2001 was discussed in the Interim RA report (Sondrup, McMurtrey, and Harvego 2003). In 2001, the inlet VOC concentrations at Unit A increased dramatically. It was postulated that the increase was the result of probe installation in VOC source areas. From December 1999 to October 2001, more than 200 probes were installed in buried waste at the SDA. One hundred forty of those probes were installed in areas of pits known to contain Series 743 waste. Sondrup, McMurtrey, and Harvego (2003) graphically compared the probe installation dates to the unit inlet concentrations to see if probing was a cause of the higher inlet concentrations in 2001. The comparison was not conclusive, but it did appear the probing was responsible for additional VOC releases.

In 2002 and 2003, the VOC removal rates were less than 0.7 kg/hr (1.5 lb/hr) as shown in Figure 9. Although this is a decrease from 2001, the rates were still higher than the trend from 1996 to 2000 would have projected. This larger than expected removal rate could be due to Unit D being started up over a year after the Unit C shutdown. The year-long shutdown should have allowed concentrations to rebound and the removal rate for Unit D should have increased. This, however, does not appear to be the case. Figure 10 shows the annual average VOC mass removal rates for each VVET unit. The removal rate for Unit D in 2001 was less than it was the previous year for its predecessor, Unit C. Figure 10 shows that in 2002 the overall average removal rate went up due to the high removal rates at Units A and B. Then in 2003, Unit A maintained the high removal rate, but Unit B's removal rate had dropped to less than Unit D. The majority of probes installed in VOC source areas in 2001 were installed in the vicinity of Unit A and it is believed that lingering releases from the probing are the cause of the high removal rates at Unit A in 2002 and 2003.

In 2004, the average removal rate was 0.93 kg/hr (2.04 lb/hr). This is a 41% increase from 2003 and the highest annual average removal rate with the exception of 0.95 kg/hr (2.1 lb/hr) in 1996, the first year of operations. Figure 10 indicates that Units E and F, and particularly Unit F, were responsible for the increase in removal rate from 2003 to 2004. The large increase at Units E and F is believed to be due to the use of new or previously unused extraction wells installed in untapped areas of high VOC concentration (e.g., Wells SE7, IE7, 6E, IE4, and 7E). If this is true the new wells at Unit D (SE6, IE6) should have produced similar increases. This, however was not the case, and is probably because Wells SE6 and IE6 are located between Well 7V (Unit D) and Wells SE7, IE7 and 8901 (Unit E). In other words, extraction wells attached to Unit E likely compete with new wells SE6 and IE6 attached to Unit D.

Figure 10 shows that the removal rates for Units E and F in 2005 (as of April 7) are down significantly from 2004. The 2005 removal rate at Unit D is up only slightly from 2004. The decline at Units E and F is most likely due to extended operation of the new VVET Units. Since coming online on April 7, 2004 until it was shut down on February 17, 2005 to be relocated because of waste retrieval activities in Pit 4, Unit E was in operation 302 of 317 days (95%). Over that same time period, Unit F was in operation 271 of 317 days (85%). In addition, both Units E and F were in operation for all but 2 days from December 1, 2004 through February 17, 2005.

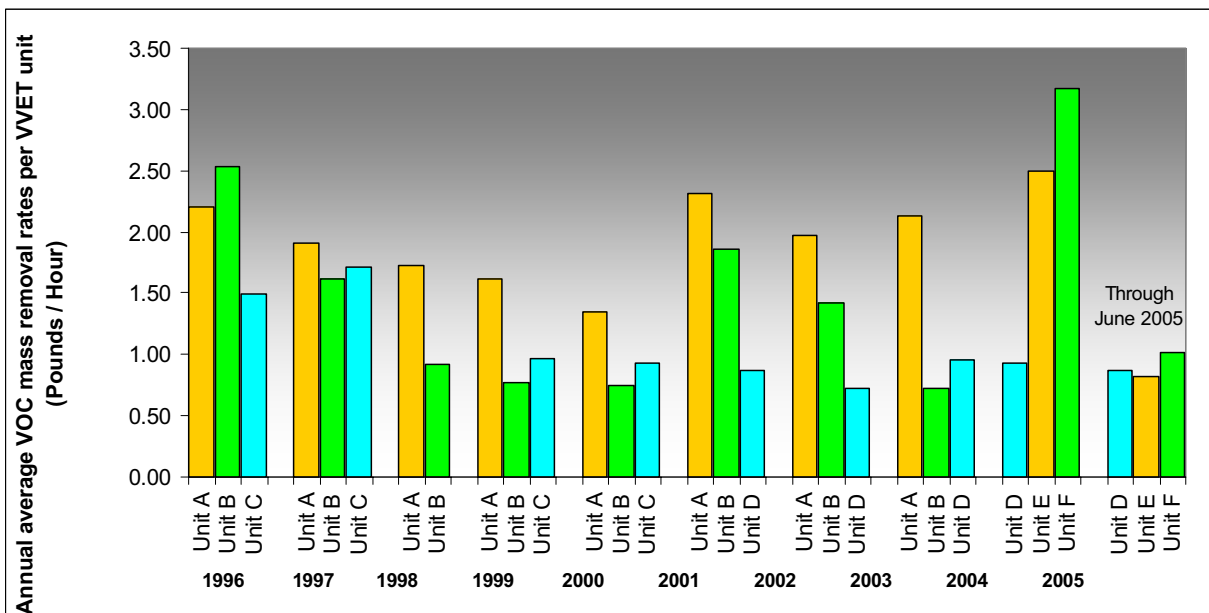


Figure 10. Annual average VOC mass removal rates per VVET unit.

Although the mass removal rates in 2005 (as of June) are down dramatically from 2004, they are still relatively high for Units D and F. The 2005 removal rate at Unit D is higher than it has been since 1997 when Unit C was located in the same location. The 2005 removal rate at Unit F is the 5th highest in that location of the last 8 years (considering removal rates at both Units F and B). And although the 2005 removal rate at Unit E is the lowest since operations began, it is still close to the removal rate in 2000, the year prior the large increase believed to be the result of probing.

3.2 Trends in Unit Inlet Concentrations

Figure 11 shows the CCl_4 concentrations at the VVET unit inlets from January 1, 2002 through June 2005. Figure 12 shows the same data, but the maximum y-value (ordinate) on the graphs has been reduced to show details at the lower concentrations. Only CCl_4 is shown because the other VOCs, though lower in concentration, behave in similar trends to CCl_4 .

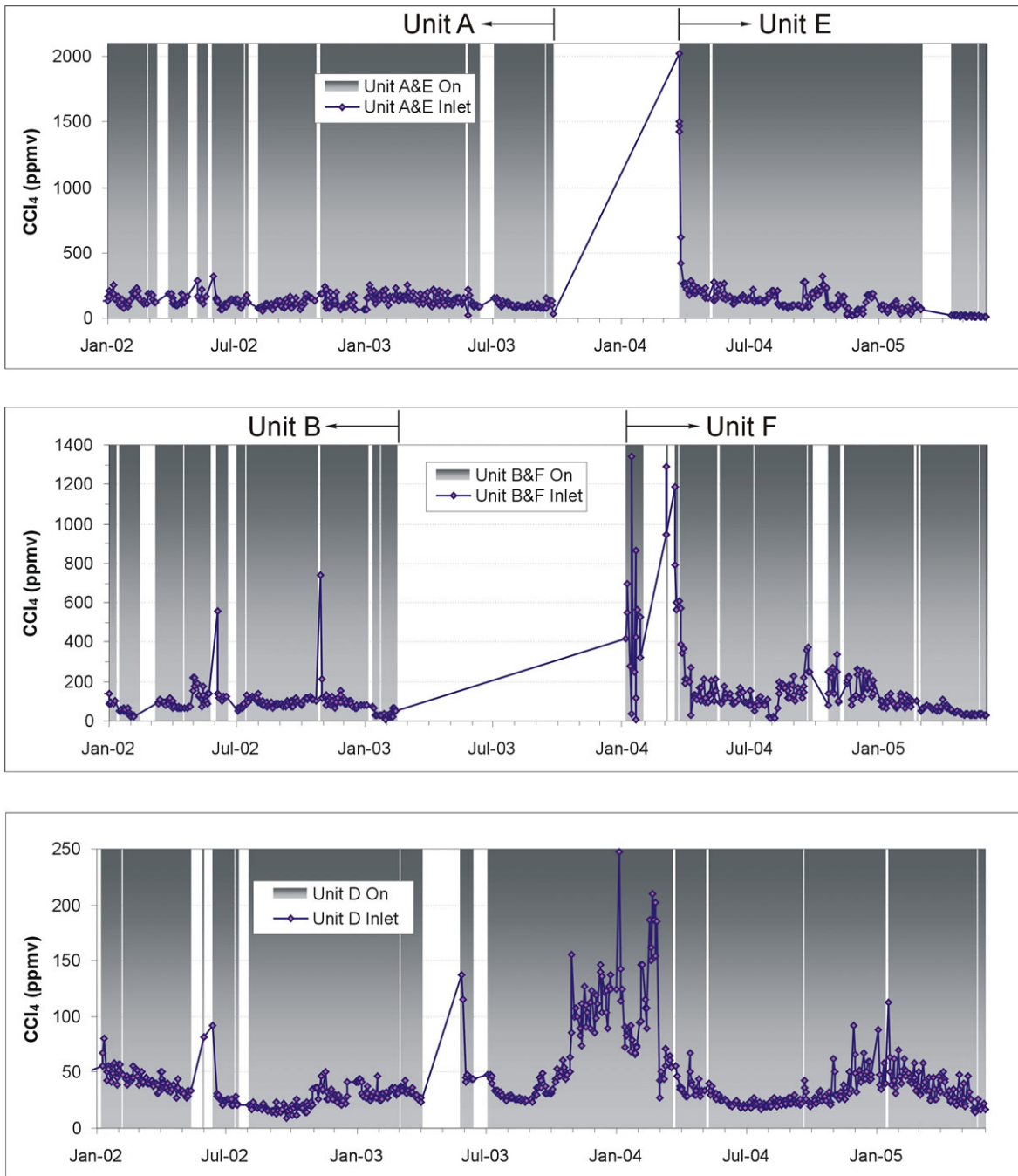


Figure 11. Carbon tetrachloride concentration at VVET unit inlets from January 2002 through June 2005.

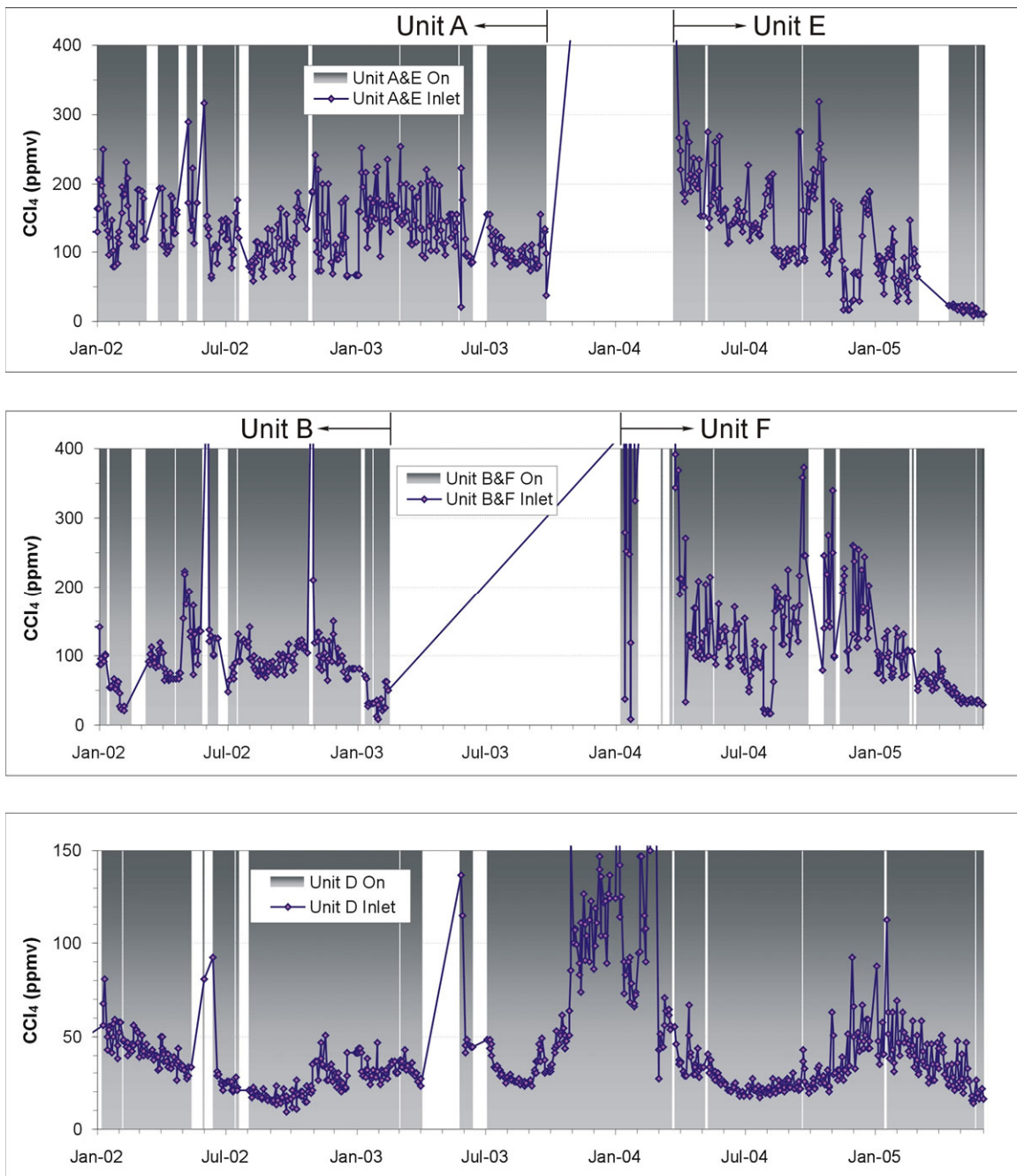


Figure 12. Carbon tetrachloride concentration at VVET unit inlets from January 2002 through June 2005 using a smaller y-axis scale.

Since January 2002, the inlet concentrations at Units A and E have generally been higher than Units B and F, and concentrations at Units B and F have been higher than Unit D. However, since Unit E began operations in March 2004, the inlet concentrations have been steadily declining and are currently about the same as Unit D (see Figure 13). Concentrations at Unit F have been declining since September 2004 and are also about the same as Unit D. Concentrations at Unit D have been relatively constant except for a noticeable seasonal fluctuation with peaks in the winter months (December–January) and troughs in the summer months (July–August). Although less obvious, the seasonal trend is evident in the Unit F data. The seasonal trend may be present in the Unit E data, but there is no local peak in inlet concentrations in December 2004. This is likely due to changes in extraction wells being utilized. Most notably, extraction from Well 6E by was discontinued in November 2004 because it was in the footprint of a new retrieval structure. Well 6E was likely a good producer of VOCs because of its close proximity to a large VOC source.

The seasonal trend in inlet concentrations makes it difficult to analyze the extraction data. For example, it is difficult to tell how much of the decline in inlet concentrations in 2005 is to be expected due to seasonal impacts, and how much is due to extended operations and a limited supply of available mass. If the inlet concentrations continue to decline during the second half of the year, an alternative strategy involving well cycling or integrated rebound periods may be necessary to increase the efficiency of the system. However, if inlet concentrations rise during the second half of the year as they have in the past, the removal rate for the year will increase and may be satisfactory.

Figures 11, 12, and 13 indicate that most of the time when a unit was shut down for more than a few days, the inlet concentrations increased, or rebounded upon startup. However, for most cases the higher inlet concentrations were reduced to what they were before the shut down after only a few hours to a few days of operation. This is typical for a soil vapor extraction system that has operated for a long period of time and is approaching or has reached a rate-limited extraction condition. The two most obvious examples of rebound occurred when Units E and F began operating after Units A and B had been shut down for 6 and 11 months, respectively. In both cases, the initial concentrations at the inlets were at least ten-fold higher than they were at the time of shut down, and although they were reduced dramatically after a few hours of operations, the concentrations remained higher than before shut down for several months.

There were times when the inlet concentrations did not rebound after a prolonged shutdown. Two of these instances occurred recently at Units E and F. Figure 13 shows that after Unit F was shut down for about 3 weeks in September and October 2004, the inlet concentration upon startup was less than before the shutdown. Similarly, when Unit E was shut down for over a month while it was relocated to accommodate a new retrieval structure in March–April 2005, the inlet concentration upon startup was less than it was before shut down. In both these cases, however, the lack of rebound may have been the result of well cycling. When Unit F was shut down in September 2004, it was extracting from Wells SE3, SE8 and 7E. When it was restarted, it was extracting from IE8, SE8 and 7E. When Unit E was shut down in March 2005, it was extracting from Wells SE7 and 8901. When it was restarted, it was extracting from Wells IE7, SE7 and 8901. While these were not big changes, they could have caused the lower inlet concentrations and masked any rebound.

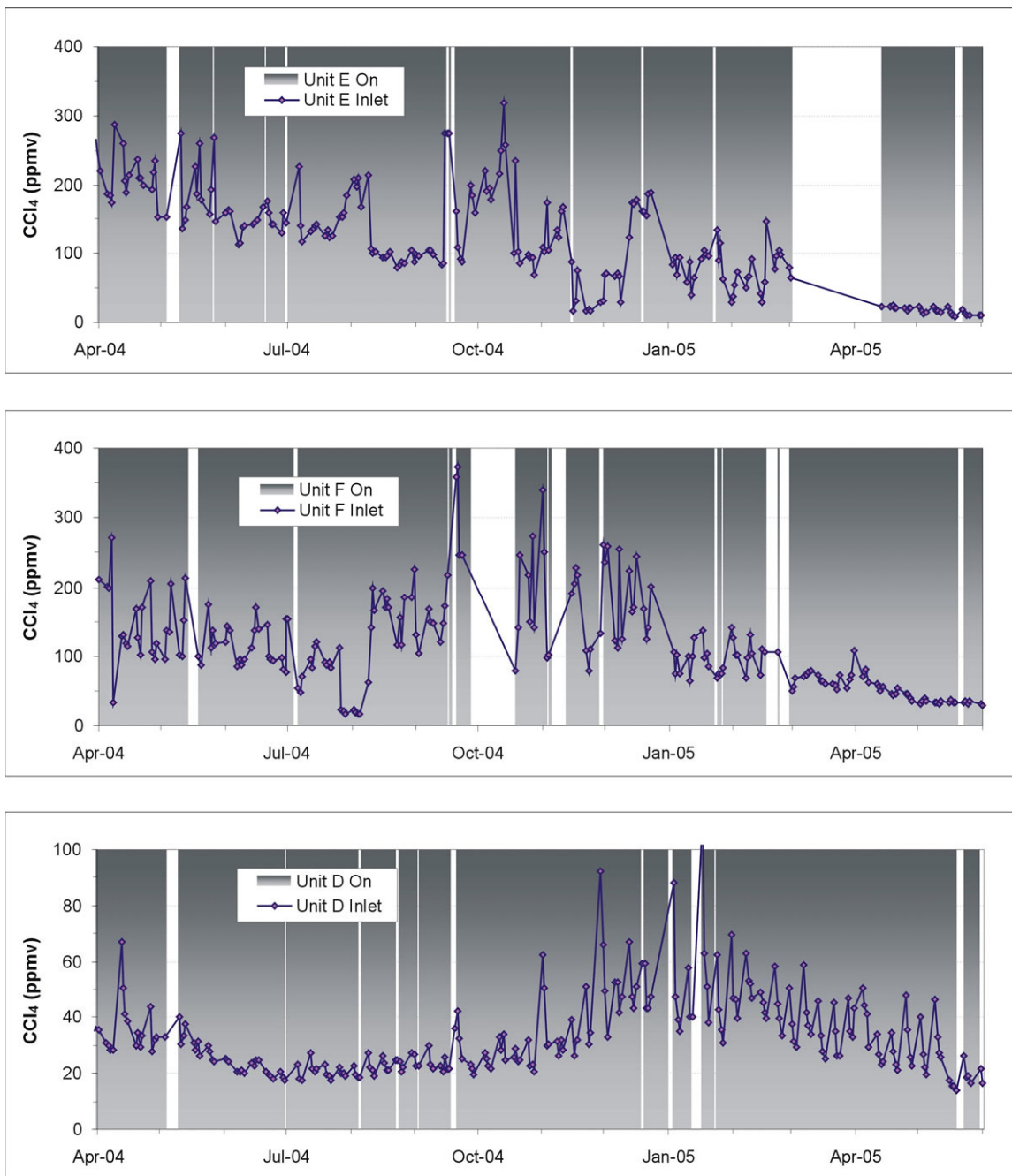


Figure 13. Carbon tetrachloride concentration at VVET unit inlets from April 2004 through June 2005.

3.3 Trends in Subsurface VOC Vapor Concentration

Vapor samples are collected and analyzed on a regular basis (usually monthly or quarterly) from permanent sampling ports, and the data are presented in semiannual reports (e.g., *Environmental and Operational End-Year Data Report for the OU 7-08 Organic Contamination in the Vadose Zone Project - 2004* [Housley 2005]). Figure 14 is a simple representation of the CCl_4 plume before the start of OU 7-08 remedial actions in January 1996. The figure is based on measurements from hundreds of soil gas samples.

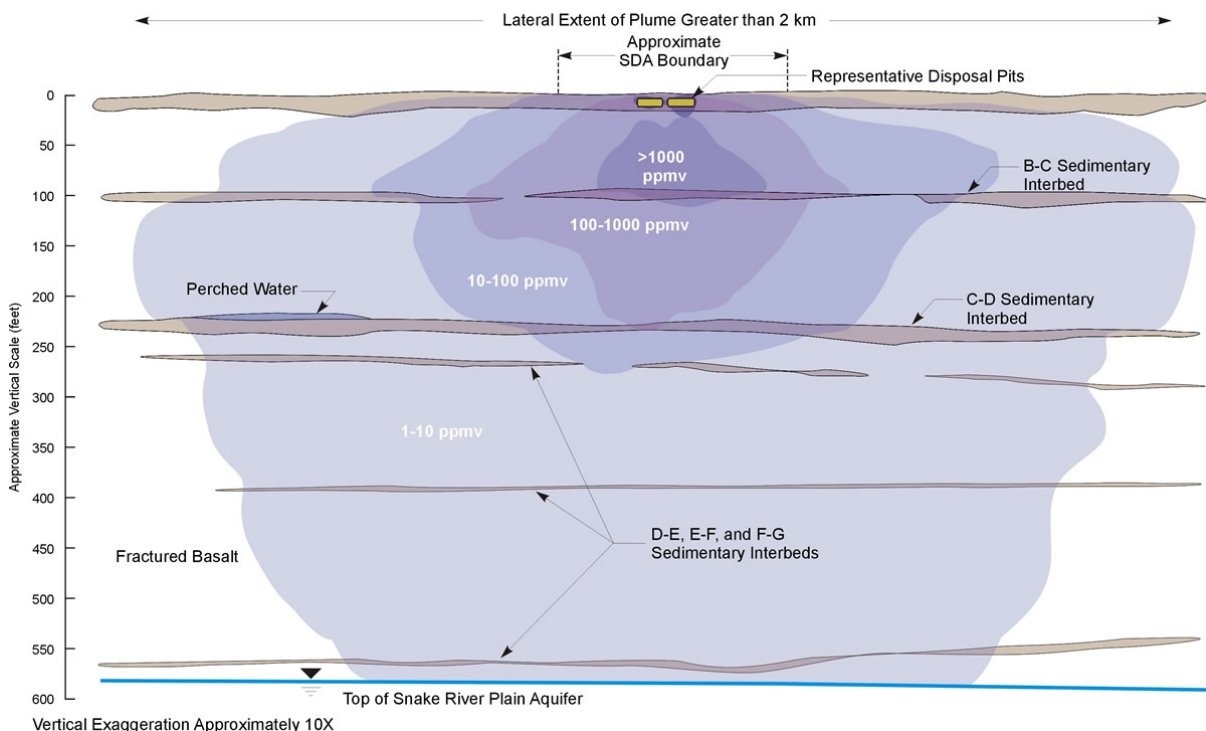


Figure 14. Conceptual drawing of the carbon tetrachloride soil gas plume before vapor vacuum extraction with treatment operations.

Since the startup of VVET operations in January 1996, soil gas concentrations have decreased markedly at many locations in response to the gas extraction. Figure 15 shows the CCl_4 concentration time history for three vapor ports in Well 9V. The VOC concentration behavior at this well is typical of wells that are not near source areas in that the concentration has been steadily decreasing since operations began in 1996. There was an increase in concentration at Well 9V in late 2003 probably due to the shutdown of Units A and B, but the concentrations came back down before new Units E and F were started.

Figure 16 shows the CCl_4 concentration above the B-C interbed at Well 9301 near vapor extraction Well 8901D, and close to a VOC source area. Before 1996, the CCl_4 concentration was approximately 3,000 ppmv at this port, and after extraction began, the concentration dropped to about 1,000 ppmv. However, when the VVET units are shut down, the concentrations in this well can rebound to 2,000 ppmv or greater. The most recent and largest rebounds occurred in 2003–2004 when Units A and B were being replaced. These dramatic rebounds are believed caused by the close proximity of the port to a still-active source.

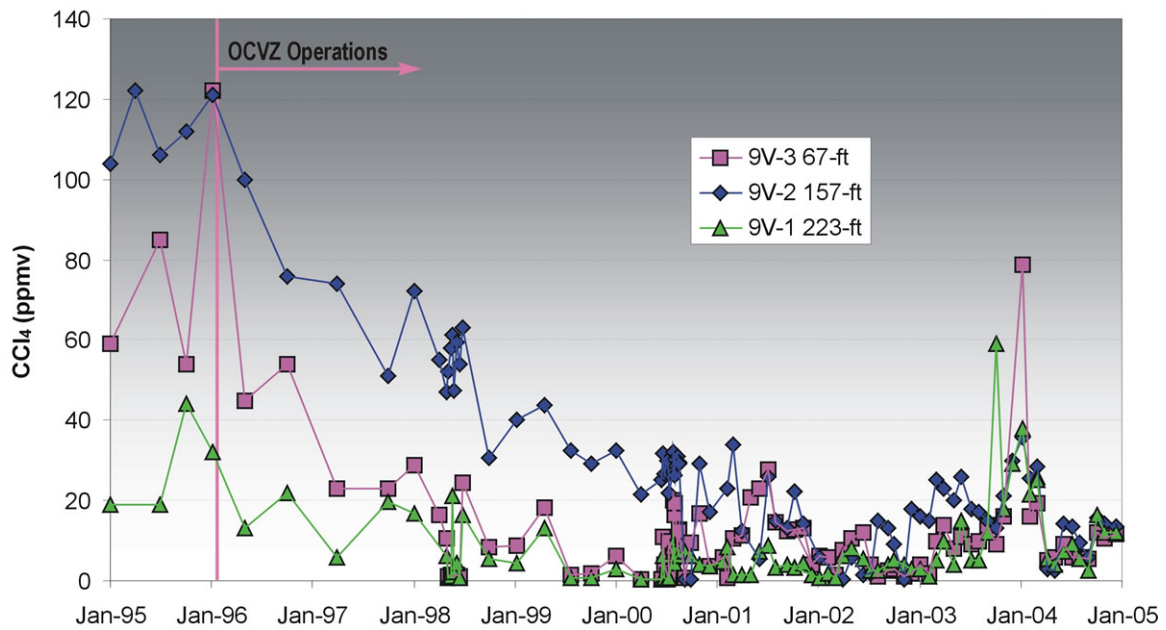


Figure 15. Carbon tetrachloride soil gas concentration time history for three ports in Well 9V.

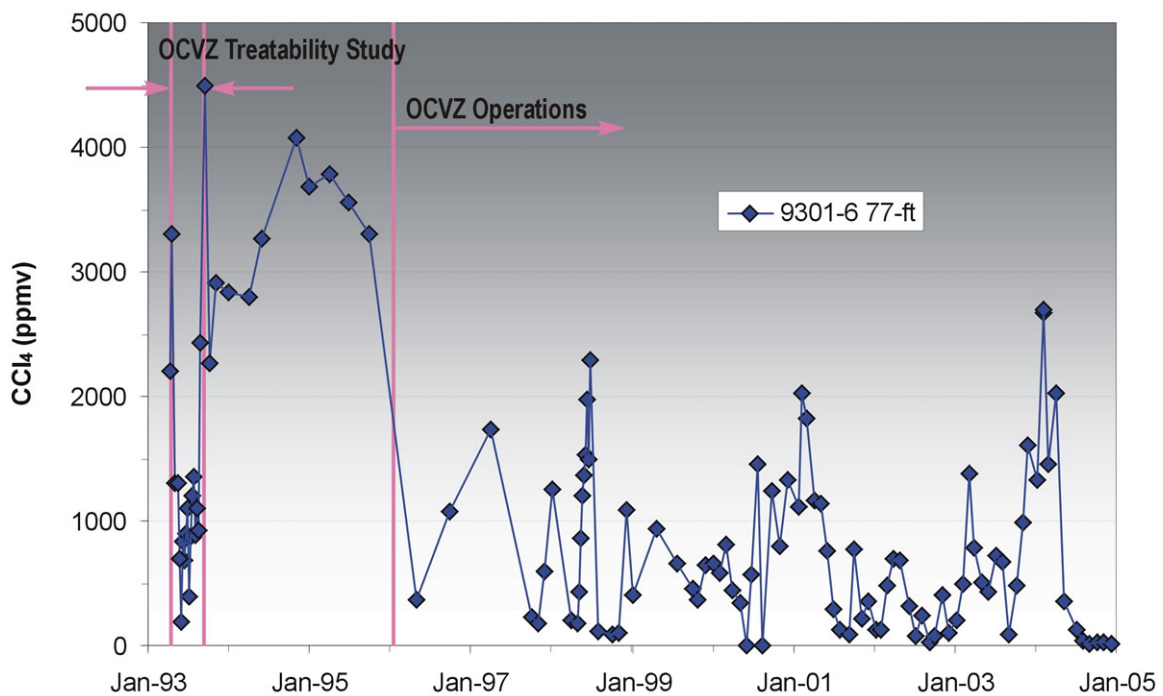


Figure 16. Carbon tetrachloride soil gas concentration time history for Well 9301, Port 6 (depth=23 m or 77 ft).

These figures show concentrations in 2005 to be significantly less than they were in 1996. However, the results may be misleading because the 2005 data do not reflect an equilibrium condition. The VVET units had been operating for an extended period of time before June 2005 without a shutdown of significant duration.

Subsurface vapor concentrations have also been used to validate unit inlet concentration data. For example, the inlet concentrations at Unit E (see Figure 13) have been unusually low since Unit E was relocated in March–April 2005. The lack of a rebound caused personnel to suspect a leak in the rerouted piping even though it had been leak checked. However, a check of CCl₄ concentrations at ports near Unit E extraction wells show that after Unit E came online in March 2004, the concentrations in the nearby monitoring wells decreased considerably both above and below the B-C interbed. Even when Unit E was shut down for nearly 6 weeks in March–April 2005 to be relocated, the concentrations in the subsurface sampling ports remained low. In fact, most of the concentrations above the B-C interbed are less than 20 ppmv following the relocation, even in Well 8902 which is about 40 m (130 ft) from the nearest extraction well. The low concentrations in the sampling ports explain why the inlet concentrations and removal rates are down in 2005.

One possible explanation for the dramatic decreases in subsurface concentrations is the new King Buck oxidizers are operating longer with less downtime than the predecessor Thermatrix oxidizers, as was discussed previously. Another likely candidate is the open-hole construction of the new extraction wells. The new extraction wells have open intervals of 18 m (60 ft) or longer and they intersect several fractures and/or rubble zones. Since the sampling ports were located adjacent to fractures or rubble zones, the new extraction wells are probably in “good connection” with the sampling ports. That is why the concentrations in the sampling ports respond so quickly to unit operations and why the concentrations have been reduced so low since the new units began operating with the new wells.

3.4 Comparison to Remediation Goals

Remediation goals (RGs) were recently updated and published in the OU 7-08 *Data Quality Objectives Summary Report* (INEEL 2005). The RGs are a key component in fulfilling the RAOs defined in the OU 7-08 ROD (DOE-ID 1994).

From a regulatory standpoint, the point of compliance for the OCVZ project is the Snake River Plain Aquifer outside the SDA boundary. However, organic chemical concentrations in groundwater cannot serve as a direct indication that the VVET systems may be shut down because of the time delay for the contaminants to migrate from the vadose zone into the groundwater. Therefore, OU 7-08 established remediation goals in the vadose zone by using a fate and transport model to establish allowable vapor concentrations such that maximum contaminant levels in the SRPA outside the SDA are not exceeded. Figure 17 shows the RGs for carbon tetrachloride for each of the six vadose zone regions/zones established in the OU 7-08 *Data Quality Objectives Summary Report*.

In Revision 2 of the OU 7-08 *Data Quality Objectives Summary Report* (INEEL 2005), part of the criteria (decision rules) for satisfying RAOs and possible suspension of VVET operations is that vapor monitoring results obtained during VVET operations and short-term rebound periods must demonstrate: (1) favorable trends (flat or decreasing) at individual sampling locations; and (2) the 95% upper confidence limit of the mean, lognormal mean, or median vapor concentrations of all sampling locations within each RG zone do not exceed the respective RGs. As of yet, this type of comprehensive quantitative comparison of measured subsurface concentrations to the new remediation goals has not been made. However, based on the measured concentrations, Zones A1 and A2 have been near or below the RGs since July 2004, a period when the units were operating nearly continuously (see Figures 18 and 19).

Figure 20 is a kriging diagram showing reductions in concentration from just before operations began until June 2005.

Although the concentrations have been less than the RGs since shortly after Unit E began operating, the concentrations measured during the 6-month-long shutdown before Units E and F were started (September 2003 to March 2004) were some of the highest measured since operations began.

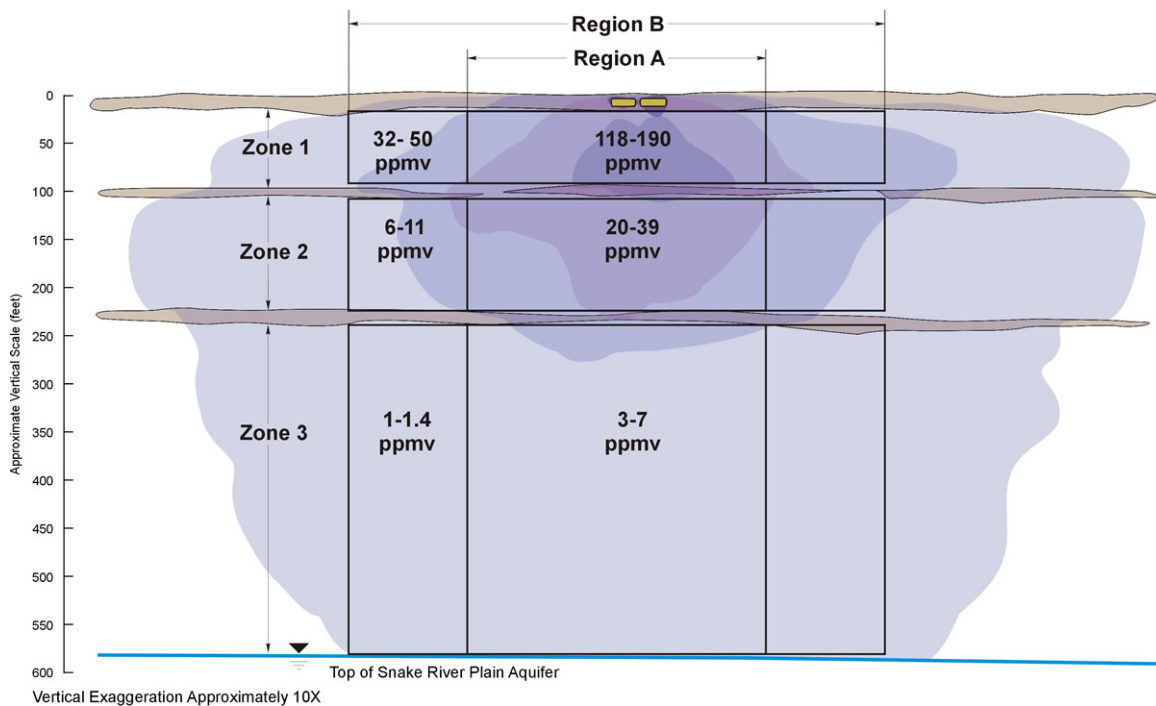


Figure 17. Cross-sectional drawing of the SDA subsurface showing the remediation goals for Zones 1, 2 and 3 in Regions A and B.

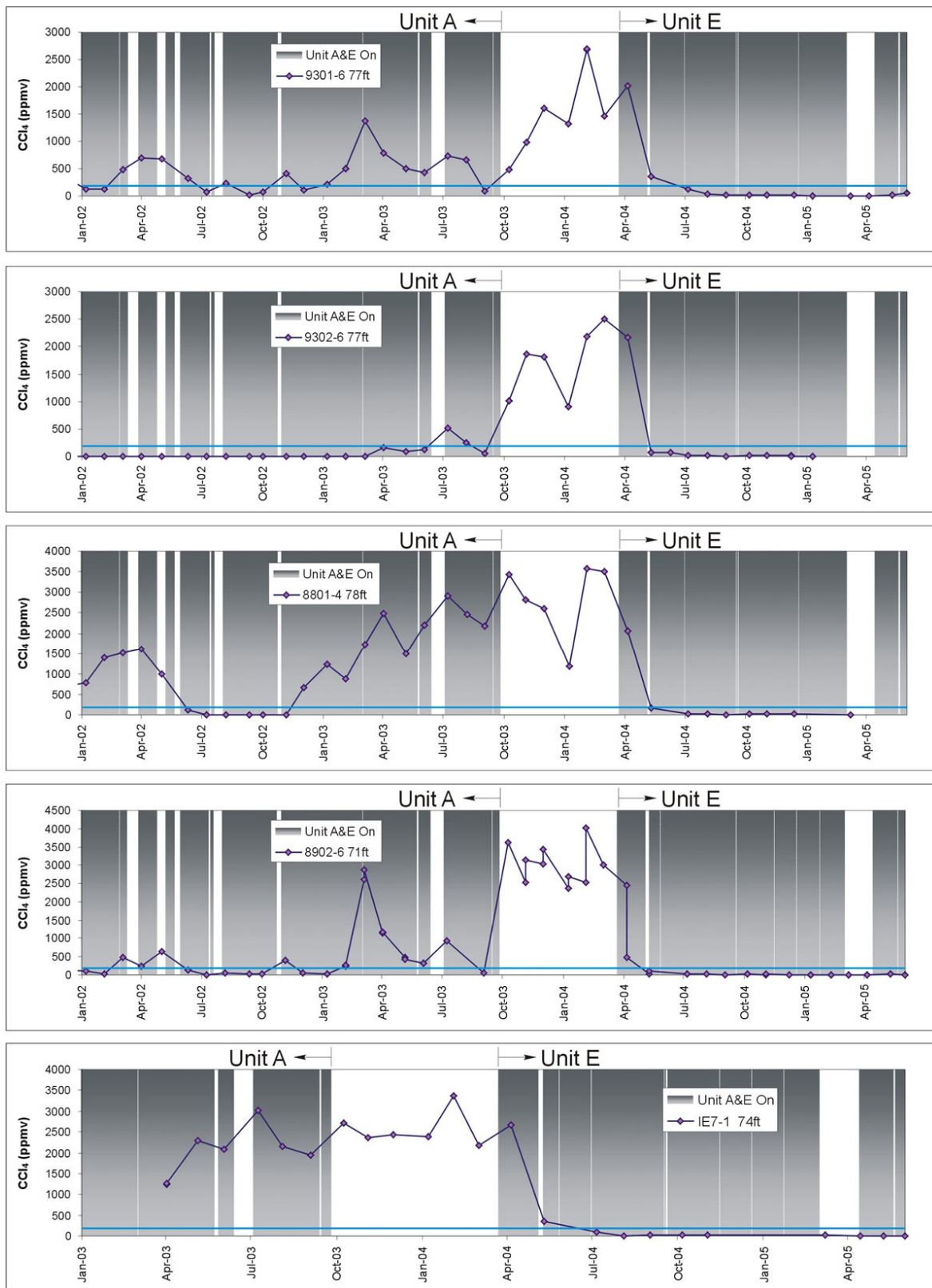


Figure 18. Carbon tetrachloride concentrations at sampling ports above the B-C interbed near Unit E extraction wells. The horizontal line represents the remediation goal for Zone A1 (190 ppmv).

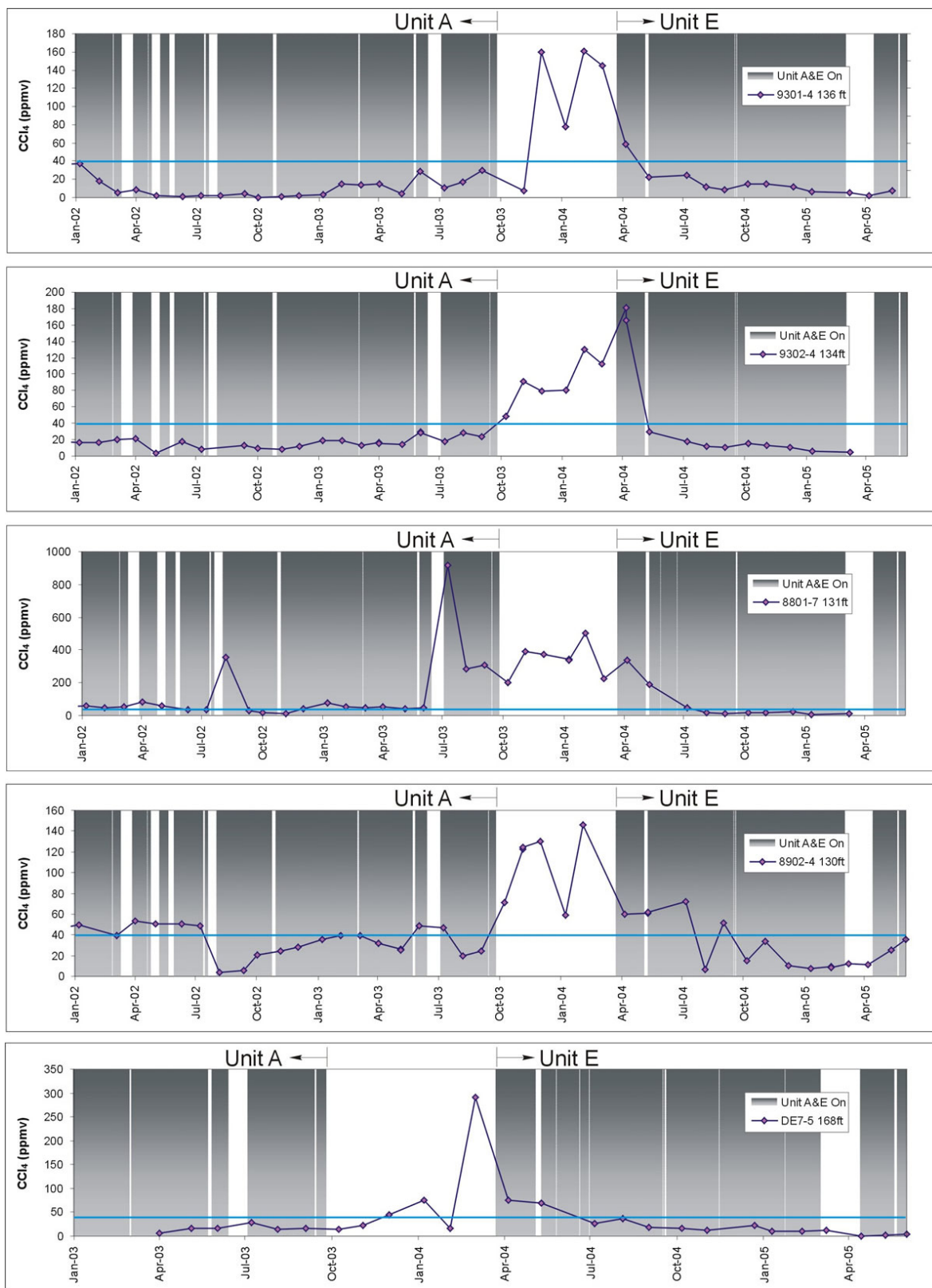


Figure 19. Carbon tetrachloride concentrations at sampling ports between the B-C and C-D interbeds near Unit E extraction wells. The horizontal line represents the remediation goal for Zone A2.

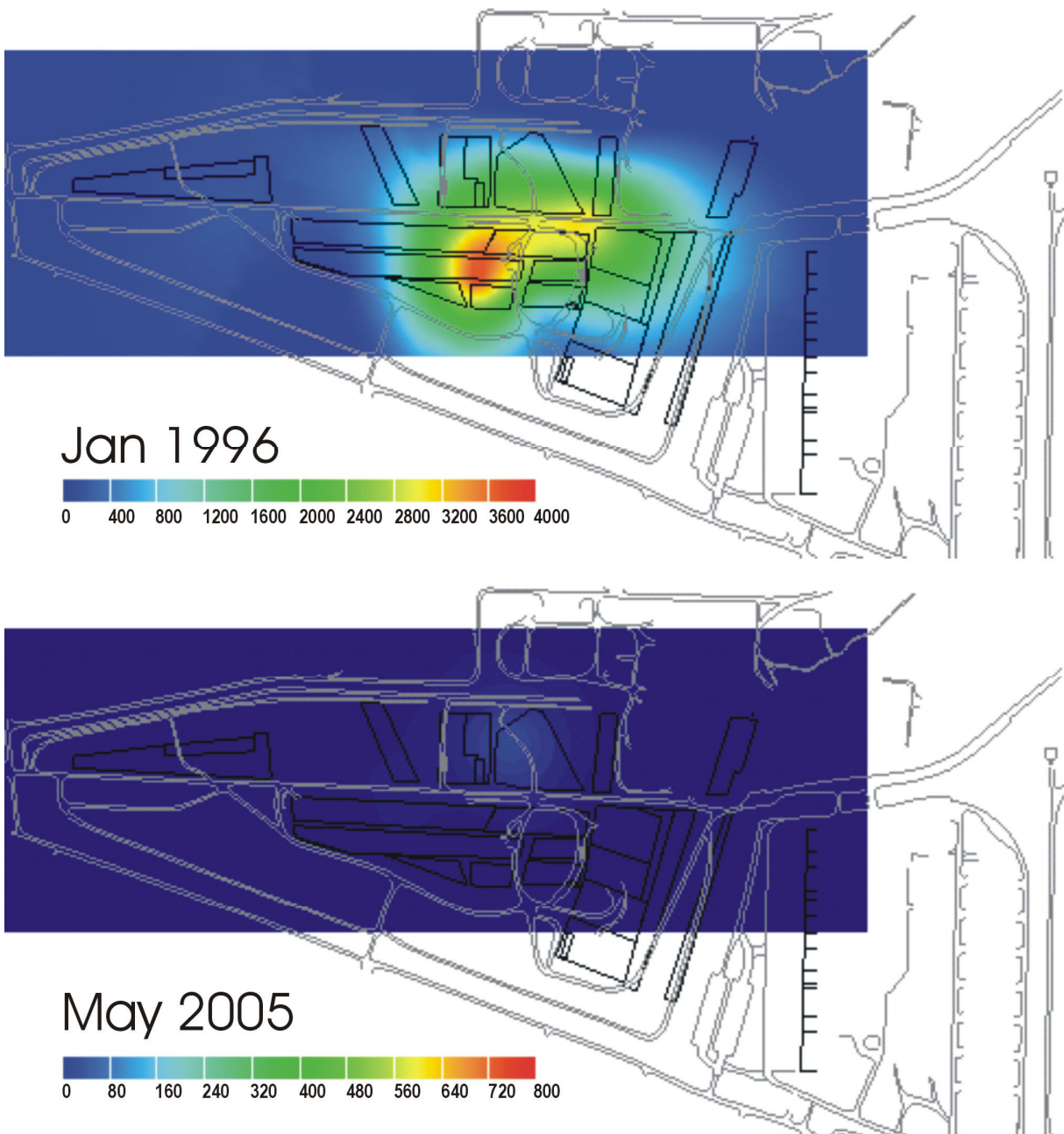


Figure 20. Carbon tetrachloride concentrations at the 21-m (70-ft) depth just before commencement of VVET operations in January 1996 and in June 2005 after 9 years of extraction. Note the different scale used in the figures.

Since Units E and F began operating with new extraction wells, the VVET system has not been shut down for rebound. Although Unit E was shut down for 6 weeks early in 2005, it was only one unit and it appeared to have little impact on subsurface vapor concentrations. With the new wells and units, the previous concept of what constitutes a rebound may not be valid and it is necessary to determine how the system responds to an extended shutdown. These rebound periods must then be planned into the operating schedule so data can be collected for comparison to RGs according to the Decision Rules for satisfying RAOs. These comparisons will be presented in future status reports.

3.5 Summary and Recommendations

From 1996 through 2000, VOC mass removal data was trending and predictable. Since that time the data have been highly variable, due primarily to recent changes to the VVET system. For example, the relatively high mass removal results in 2004 are due primarily to three factors: (1) the three new catalytic oxidizer units (D, E, and F) are more reliable and were operating for most of 2004, (2) many of the new extraction wells which began being used in 2004 are located in more highly concentrated areas of the plume, and (3) Units A and B were down for a large portion of 2003 while being replaced with Units E and F, allowing concentrations in those areas to rebound during the downtime.

The mass removal rate in 2005 is down considerably from 2004 due to large decreases at Units E and F. One reason for this may be the new catalytic oxidizers operate longer between shutdowns compared to predecessor units and therefore reach a rate-limited condition where the rate of VOC extraction is controlled by processes such as diffusion, partitioning, and even container failure. Since the startup of Units E and F, the inlet concentrations and subsurface concentrations have declined and continue to decrease in response to the nearly continuous operations. Part of the decline, however, may simply be seasonal, and it is recommended that the inlet concentration data be scrutinized in the second half of 2005 to see if there is an increase as observed in historical data.

To increase the efficiency of the removal process, alternative extraction strategies should be investigated such as built-in rebound periods and/or well cycling. Rebound periods will help increase efficiency, but are also necessary to provide the required data for comparisons to remediation goals. Data should be collected on a more frequent basis during the rebound period to determine the appropriate duration. Well cycling will allow extraction from other areas not previously used.

To develop an efficient strategy for establishing rebound periods and cycling of extraction wells, it is recommended that concentration data from individual wells be collected. Currently several extraction wells are manifolded together, but only one sample is taken at the inlet to the unit. A plan is being developed to take VOC samples at individual wells. The individual well data will help determine which wells are most productive and when they become unproductive. This information can be used to determine the initiation of a rebound period or cycle to other production wells.

4. OPERABLE UNIT 7-08 REMEDIAL ACTION COST SUMMARY

The first phase of remedial action operations (i.e., Phase I) was initiated in January 1996 and continued through January 1998. In 1998, following a decision by the DOE, Environmental Protection Agency (EPA), and DEQ, the remedial action transitioned into the second phase of operations. Phase II remedial action operations and monitoring is continuing to use oxidizer systems to remove and treat organic contaminated vapors from the vadose zone. During the Phase II remedial action, thermal oxidizers were replaced by catalytic oxidation systems and eighteen extraction and/or monitoring wells were installed inside the SDA at varying depths. Total remedial action costs incurred through September 30, 2004, are shown in Table 5.

Table 5. Operable Unit 7-08 remedial action costs through Fiscal Year 2004.

Description	Operable Unit 7-08 Project	Operable Unit 7-08 Record of Decision (Estimate) (DOE-ID 1994)
Construction (including capital cost)	\$6,061,521	\$14,942,222
Operations and maintenance (including monitoring costs)	\$17,615,205	\$35,467,968
Postclosure monitoring	\$0	\$16,776,243
Total costs through September 30, 2004	\$23,676,726	
	Total 35% of the Record of Decision estimate for completion	\$67,186,433

5. SYNOPSIS AND VERIFICATION OF WORK PERFORMED

This section provides a synopsis of the VVET operation and identifies the documentation that verifies performance of the remedial action activities.

5.1 Synopsis of Remedial Action Activities

OU 7-08 OCVZ Phase II remedial action operations began in January 1998, the end-date of the *Final Phase I Remedial Action Report for Organic Contamination in the Vadose Zone Operable Unit 7-08* (Higgins 1997). Phase II remedial action operations are expected to continue until remediation goals are met and active extraction operations are no longer required. The VVET extraction and treatment system operates continuously with the exception of planned downtime for preventive and corrective maintenance. Occasionally, the treatment system is shut down due to uncontrollable outages such as weather or power related outages.

5.2 Verification of Work Performed

Data reports summarize the remedial action activities on a semiannual basis. These data reports document operational and sample data which is trended over time and used to assess the effectiveness of the remedial action and assist in determining active extraction operation strategies.

Operating logs are completed daily by the VVET technicians. Data recorded in the logs include operating parameters for each VVET unit, maintenance activities, outages, etc. VVET unit operating parameters, including temperature, pressure, and flow, are also recorded electronically on the VVET-SCADA computer.

6. OPERATIONAL AND FUNCTIONAL REMEDY CERTIFICATION

Pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act regulations, “[a] remedy becomes operational and functional either one year after construction is complete, or when the remedy is determined concurrently by EPA and the DEQ to be functioning properly and is performing as designed, whichever is earlier” (40 CFR 300.435 (f)(2), [2004]). The OU 7-08 remedy was reported to be operational and functional in September 1997 as part of the *Final Phase I Remedial Action Report* (Higgins 1997) and continues to be operational and functional through this interim reporting period. The remedial action is effective at reducing the volatile organic contaminant concentrations in the vadose zone, and the areal extent of the contaminant plume has decreased since the beginning of remedial action operations. The CCl₄ concentration in the vapor plume has been reduced by an order of magnitude at most sampling locations within the SDA.

7. SCHEDULE FOR CONTINUATION OF REMEDIAL ACTION ACTIVITIES

The OU 7-08 remedial action, as described in the OU 7-08 ROD (DOE-ID 1994), is designed to add additional phases, as needed, to ensure the selected remedy achieves RAOs. For cost estimation purposes, an assumption incorporated into the ROD (DOE-ID 1994) was that remedial action would occur in three phases with each phase having a duration of 2 years. The ROD (DOE-ID 1994) stated that the actual duration of each phase would depend on elements, such as equipment procurement and installation, that may be involved with each potential phase transition. In addition, organic waste remaining in the pits could extend the timeframe required to achieve RAOs using the selected remedy because the remaining organic waste could act as a long-term source of organic contamination in the vadose zone. Operations, maintenance, and monitoring for Phase II, the second phase of the remedial action, are expected to continue until active extraction is no longer required to ensure that the RAOs will be met. Project lifecycle planning assumes that the risk from the organic contamination will be reduced to the remediation goals where active extraction within the SDA will not be required beyond 2018. This estimate is based on the following assumptions:

- The OU 7-13/14 ROD will be finalized in 2008.
- The selected remedy for OU 7-13/14 will be implemented in 2010.
- The selected remedy for OU 7-13/14 will reduce the risk from organic contamination and limit migration of contamination to the vadose zone.
- Once the risk from organic contamination is reduced, no more than 7 years (i.e. 2012–2018) will be required to extract and treat organic vapors in the vadose zone. Monitored vapor concentrations must satisfy the conditions required for shutdown of active extraction (INEEL 2005).

Once the decision has been reached to shut down active extraction, the remedial action will transition into Phase III. During Phase III, a compliance verification period will be initiated. Sampling during the compliance verification phase will provide the information necessary to decide if the system needs to be restarted or if the system can be shut down, thereby concluding the remedial action and initiating the long-term monitoring phase. The project assumes a minimum of 1 year for compliance verification (i.e., 2019). The long-term monitoring phase is initiated after the remedial action is complete. During the long-term monitoring phase, the VVET systems remain shut down, and vapor monitoring is conducted at a lower frequency than during operations or compliance verification periods.

8. ENFORCEABLE MILESTONE

The following document has been determined to be an enforceable milestone for the OU 7-08 remedial action, assuming a 2018 completion. The associated date is for submittal of the draft document to the agencies.

- Draft “Final OU 7-08 Remedial Action Report,” December 15, 2020.

9. REFERENCES

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